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Programme in Environmental Science**

*The contribution of the Mexican environmental policies
to the efficient solution of the problem of air pollution"*

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ANA

Abstract

The objective of this study is to investigate whether there have been any significant advances concerning the solution of the problem of air pollution in Mexico. The paper will argue that the designed policies developed to solve the problem of air pollution have shown partial effects. In this sense, the aim of this research is to make an evaluation of the evolution of air pollution policies developed by the Mexican Government from 1994 until the present. The methodology is based on the SPIR (State-Pressure-Impact-Response) conceptual framework. The results of the research show that there are different approaches concerning environmental policy in the solution of air pollution that have important implications for the management of the problem. These policies and objectives affect not only the scope, but also the goals and targets that environmental policymakers should aim at. The conclusion of the study is that the actions taken until the present time by the Mexican government should be seen as a necessary but not sufficient condition for the efficient solution of the air pollution problem in Mexico.

List of Acronyms

CAM	*Comisión Ambiental Metropolitana* (Metropolitan Environmental Commission)
CENICA	*Centro Nacional de Investigación y Capacitación Ambiental* (National Center for Environmental Research and Training)
CEPAL	*Comisión Económica Para América Latina* (Economic Commission For Latin America)
DF	*Distrito Federal* (Federal District)
EM	*Estado de México* (State of Mexico)
HC	Hydrocarbon
HNC	*Hoy No Circula* (No Driving Day Program)
IMECA	*Indice Metropolitano de Calidad del Aire* (Metropolitan Index of Air Quality)
INE	*Instituto Nacional de Ecología* (National Institute of Ecology)
INEGI	*Instituto Nacional de Estadística, Geografía e Informática* (National Institute of Statistics, Geography and Information Science)
LGEEPA	*Ley General de Equilibrio Ecológico y Protección al Ambiente* (General Law of Ecological Balance and Protection to the Atmosphere)
MCMA	Mexico City Metropolitan Area
MIT	Massachusetts Institute of Technology
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization
NOM	*Norma Oficial Mexicana* (Mexican Official Norm)
NO_x	Nitrogen oxides
OECD	Organisation for Economic Cooperation and Development
PAN	Peroxyacetyl nitrate
PEMEX	*Petróleos Mexicanos* (Mexican Petroleum –The national oil company of Mexico)
PICCA	*Programa Integral Contra la Contaminación Atmosférica* (Comprehensive Program Against Air Pollution –Mexico City's Official Air Pollution control plan for 1990-1995)
PM_{10}	Mass of particulate matter with aerodynamic diameter smaller than 10μm
ppm	parts per million
PROAIRE Improve	*Programa para Mejorar la Calidad del Aire en el Valle de México* (Program for Air Quality in the Valley of Mexico)
O_3	Ozone
PROFEPA	*Procuraduría Federal de Protección al Ambiente* (General Attorney's Office for Environmental Protection)
RAMA	*Red Automática de Monitoreo Ambiental* (Automatic Air Quality Monitoring Network)
RETC	*Registro de Emisiones y Transferencia de Contaminantes* (Registry of emissions and pollutant transfer)
SCT	*Secretaría de Comunicaciones y Transporte* (Secretariat of Communications and Transport)
SEDESOL	*Secretaría de Desarrollo Social* (Secretariat of Social Development)
SEDUE	*Secretaría de Desarrollo Urbano y Ecología* (Secretariat of Urban Development and Ecology –until 1992)
SEMARNAP	*Secretaría de Medio Ambiente, Recursos Naturales y Pesca* (Secretariat of Environment, Natural Resources and Fisheries –until 2000)
SEMARNAT	*Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources – since 2000)
SO_2	Sulfur dioxide
UNEP	United Nations Environmental Program
VOC	Volatile Organic Compound
WHO	World Health Organization

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Chapter 1: Introduction

The overexploitation of natural resources at a global level that the industrial and technological development has produced, especially since the second half of the 20th century, coupled with the fast urbanization of cities and the growth of global population has contributed to the development of various environmental problems around the world. An environmental problem is defined as "any physical change generated in the environment that is produced by the human interference, having effects that are considered unacceptable by the norms of the society"[1]. The nature and magnitude of some of these environmental problems are transboundary in nature and as a result impact multiple countries. Environmental problems are characterized by uncertainty and a lack of established geographical limits; therefore, they are considered as a threat to the international community.

One of the most complex environmental problems we now face is air pollution, due to the variety of sectors that it involves (energy, industry, agriculture, transport and forestry). In this sense, the phenomenon of air pollution can be natural or human made; the latter involves harmful amounts of natural and synthetic materials being transmitted into the atmosphere as a consequence of human activity. Pollutants can be added to the air directly as primary pollutants or they can be created in the air as secondary pollutants under the influence of solar radiation. The major air pollutants, which have documented environmental and health risks, include nitrogen oxides, sulfur dioxide, ozone and particles. Air pollution also affects and alters the climate and the chemistry of soil, lakes and rivers.[2]

Mexico - a developing economy - is currently confronting the consequences of poverty and underdevelopment and faces tough ecological, economic and social challenges. Different facts are contributing to these challenges. To begin with, the industrial development that the country experienced was encouraged by subsidies for energy consumption, without any consideration of the social and environmental costs. Apart from being a petroleum producer country, Mexico has an expanding population demanding energy and food. Consequently, the country depends largely on fossil fuel sources to develop its economy. Moreover, Mexico registers one of the highest rates of deforestation in the Latin American region; in Mexico, according to the United Nations, the percentage of forested land area diminished from 32.2% to 28.9% between 1990 and 2000[3], as a result of an agricultural model that had the tendency to create agricultural and cattle land in forestry areas. Mexico has also signed several international economical, commercial agreements, international organizations, such as the 1994 North American Free Trade Agreement (NAFTA). the Organisation for Economic Cooperation and Development (OECD) membership has pressed the country to enter in an accelerated process of industrialization.

As a result, the industrialization process has had direct effects on the increasing levels of air pollution in several Mexican cities, which are now confronting dangerous levels of atmospheric pollutants[4]. In this sense, the biggest urban areas of Mexico are affected from air pollution. According to the Secretariat of Environment and Natural Resources (SEMARNAT), the major sources of air pollution are the emissions coming from the transport sector. Transport emissions represent 70% of the total volume that go to the atmosphere, divided in 95% of Carbon Dioxide (CO) emissions, 70.5% of Nitrogen Dioxide (NO) emissions and 43% of hydrocarbons (HC) emissions. Private vehicles are the principal source of emissions.[5] It is important to recognize that automobile use is a major aspect of modern life, which represents a certain lifestyle and socio-economic status. These facts, common in

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[1] Pieter Glasbergen and Ron Cövers, "Environmental problems in an international context" in Pieter Glasbergen and Andrew Blowers (eds.), *Environmental problems in an international context 1:. Perspectives in environmental problems*, (London: Arnold, 1995), p. 43

[2] Aulay Mackenzie, Andy S. Ball and Sonia R. Virdee, *Instant Notes in Ecology,* (New York: BIOS scientific publishers, 2000), p.283.

[3] Cynthia Z. Arochi, "Deforestation: from the global to the local", (Unpublished manuscript, 2004), p. 1.

[4] Secretaria de Medio Ambiente y Recursos Naturales and Instituto Nacional de Ecología, *Segundo Almanaque de datos y tendencias de la calidad del aire en seis ciudades mexicanas*, (México DF: INE, 2004), p. 2.

[5] SEMARNAT, *Informe de la situación del medio ambiente en México: Compendio de estadísticas ambientales*, (México DF: SEMARNAT, 2003), p.156.

Mexico, together with the increase of population and other technological products that directly or indirectly demand the burn of fossil fuels, explain the growing volumes of pollutants that go to the atmosphere.

Accordingly, designing efficient policies against air pollution is one of the main challenges that the Mexican government is facing and has to deal with in the coming years. In this study it is argued that there have been significant advances in the strategy used to combat the problem of air pollution. However, the designed policies developed to deal with the problem of air pollution have proven to be only partially effective.

Hence, the aim of the research is to evaluate the evolution of the air pollution policies developed by the Mexican Government in the last years, from 1994 until the present time. Also, it will show the different ways in which this area of study frames various approaches to environmental policy geared at solving air pollution. Moreover, the designed policies and objectives developed by the governmental authorities affect not only the scope but also the aim, the purpose and the targets that environmental policymakers relate to the solution of this environmental problem. The actions taken up to now by the Mexican government should be seen as a necessary but not sufficient tool for solving the air pollution problem in Mexico. Hence, due to the close relationship between the different factors that produce air pollution, it is important to study the components that create this situation, the environmental effects and the political process through which the Mexican government attempts to confront the problem of air pollution in the case of mega-cities like Mexico City.

Mexico City represents a significant case for environmental research since this mega-city is regarded as one of the most polluted in the world, (Figure 1).[6] As Yip and Madl mention in their study "levels of almost any pollutant like NO_2 now regularly break international standards by two or three times. Levels of O_3, a pollutant that protects us from solar radiation in the upper atmosphere but is dangerous to breathe, are twice as high here as the maximum allowed limit for one hour a year and this occurs several hours per day every day."[7]
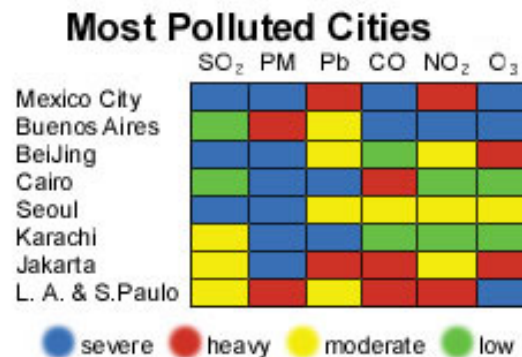
Figure 1. Source: Maricela Yip and Pierre Madl, Air pollution in Mexico City 2002

However, there are other authors, such as Zolla, who point out that until 1996 the transport sector contributed to at least half of the city's total emissions[8]. There is clearly a drastic increase from 50% in 1996 to 70% in 2003 of the emissions from the transport sector. One of the main signs of the only partial success of the Mexican policies aiming to decrease urban air pollution is the smog that is

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[6] Michelle Hibler, 2003 "Taking control of air pollution in Mexico City", USA: The International Development Research Centre, http://web.idrc.ca/en/ev-29135-201-1-DO_TOPIC.html (consulted on 16/11/04).

[7] Marcela Yip and Pierre Madl 2002 "Air Pollution in Mexico City: Project-Study paper", Salzburg: University of Salzburg, http://www.sbg.ac.at/ipk/avstudio/pierofun/mexico/air.htm (consulted on 28/10/04).

[8] Kristen Zolla, "Does limiting the time an automobile can be used effectively reduce car use?", Colby College, 1996, p.2, According to the National Institute of Ecology in Mexico (INE), the main pollutants are Carbon Monoxide, Sulfur Dioxide, Lead, Nitrogen Dioxide, Hydrocarbons. José Lezama also agrees in this perception in his book *Aire Dividido, Critica a la política del aire en el valle de México*, (México DF: El Colegio de México, 2000), p. 81.

visible in the sky above Mexico City. This is a consequence of the blending of nitrogen dioxide with other pollutants and the atmospheric water vapor that produces brown smog.

1.1 Scope and objectives

Nowadays, important measures are being implemented in the Mexican environmental political agenda. However, these measures[9] have to be effectively designed and implemented to achieve the national goals that Mexico has committed itself to. One of these goals is to provide a better air quality for its population. [10] Hence, the interest in the present research lies in the evaluation and analysis of the current policies that Mexico has adopted to combat air pollution. The scope of the study will concentrate in the period from 1994 until the present. One of the reasons for the adoption of this period is because in this year the North American Free Trade Agreement (NAFTA) entered in action, having a direct influence in the model that the Mexican government adopted for the design of pollution standards. Moreover, in the previous years the topic of air pollution was not as relevant as it became after the creation of the Secretariat of Environment, Natural Resources and Fisheries (SEMARNAP) in 1994, currently Secretariat of Environment and Natural Resources (SEMARNAT). This Secretariat assumed responsibility for this policy area. Additionally, the creation of air quality targets for other megacities apart from Mexico City using the Air Quality Metropolitan Index (IMECA) set in the national environmental programs from 1995-2000 and 2001-2006 and the introduction of catalytic converters became mandatory in new cars in this year.

The present research is divided into the next parts:

The research questions are related to what we want to know about the problem and are the following:

1) What have been the evolution and the improvements of the Mexican environmental policy in the design of measures to control the problem of air pollution?

2) Is the institutional set-up efficient in order to address the problem of air pollution in Mexico?

In an attempt to answer these questions and demonstrate the validity of the argumentation, the following hypotheses are presented:

1) If the Mexican governmental efforts to create instruments and programs to control air pollution are insufficient, then Mexican participation in international agreements, action plans and protocols will have only partial effects in the solution of the problem of air pollution.

2) If the actual policies aiming to decrease the problem of air pollution in Mexico are only partially effective, then they will be showing inadequate signs to solve the problem of air pollution in the principal cities of Mexico.

3) If the case of Mexico City is representative of the limited efficiency of national environmental policies targeting air pollution, then air pollution in Mexico City stands as a challenge for the Mexican government to elaborate effective environmental policies.

The project seeks to reach the following research objectives:

1) Determine whether the country has succeeded in structuring a national policy where urban air pollution takes a central place. (design of policies).

2) Characterize whether there have been significant advances in the implementation of policies to reduce the levels of urban air pollution. (implementation of policies).

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[9] These measures will be presented and analysed in chapter 3.
[10] Programa Nacional de Medio Ambiente y Recursos Naturales 2000-2006, *El México que queremos*, (México DF: SEMARNAT, 2000), p.63.

3) Analyze whether the actions taken by Mexico to confront the problem of urban air pollution reduce the threat to human health. (effectiveness of policies).

1.2 Conceptual Framework, method and material

In Mexico the governmental policies started to address the problem of air pollution due to the influence and pressure that other countries exercised on Mexico's policy-makers. This started through the commitments established with the signing of certain international agreements with "soft law" provisions. These are defined as "not binding documents drawn up by international bodies that establish norms; these documents can take on the force of law through customary practice"[11]. Some examples are Agenda 21 and the Cooperation for the Protection and Improvement of the Environment and Transboundary Problems known as the La Paz Agreement signed with the United States of America. Nowadays, the context of the state of the environment in Mexico occurs mainly under the perspective of the North American Free-Trade Agreement (NAFTA), which in some sense mandates the increase of awareness and protection standards of the environment at the level of the United States of America.

Hence, Mexico has had a direct influence from the USA concerning the better design of policies in relation to the case of air pollution. This is evident with the realisation of bilateral negotiations between Mexico and the North American Commission for Environmental Cooperation (CEC) as well as the North American Development Bank (NADBank). These two institutions aim to provide funding to Mexican institutions to create the proper infrastructure to deal with different environmental areas related to the Mexican-American border.

Even if there is a clear decrease of air pollution in the current years in big megacities with respect to different pollutants, the developed policies have presented only partial results with respect to eliminating or significantly reducing harmful pollutants like O_3 and PM_{10}.[12] Accordingly, there is a limited effect in the policy-making even if different programs have been implemented since 1990 with the purpose to decrease air pollution. Even if they have achieved a partial reduction of substances such as sulphur dioxide and carbon monoxide, the programs have not managed yet to decrease the problems of ozone, suspended particulates and hydrocarbons.

The severity of this situation has developed an interest among the scientific community all over the world to find effective solutions to this problem. Some of the scientific studies have focused on the chemical composition of the substances and meteorological conditions that exacerbate and in some cases overspread pollutants in the atmosphere, together with the major sources of emissions, particularly from sectors that are contributing to this problem. Significant progress has also been made in the study of the effects on human health caused by air pollution. Nevertheless, as Jose Luis Lezama points out, these studies have focused on the physical and chemical dimension and technical aspects of the problem.[13] As a consequence, they have ignored many relevant aspects for which no solution has been provided. This is particularly true of the social aspects of pollution.[14] This author also points out that social scientists have the idea that there is a social dimension to environmental problems, as in the case of air pollution. The existence of this kind of problems depends on a process through which the society values and sees the problem. It is through that perception that these problems reach public recognition.

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[11] Gareth Porter and Welsh Brown, *Global Environmental Politics: Dilemas in the world politics*, (Boulder: Westview Press, 1991), p. 191.
[12] Op. Cit, SEMARNAT et al. *Almanaque de tendencias y de la calidad del aire en seis ciudades mexicanas*, pp.1-8. Also see, SEMARNAT, Gobierno del Edo. de México, Gobierno del DF Secretaria de Medio Ambiente, Secretaria de Salud, *Programa para Mejorar la Calidad de la Calidad del Aire de la Zona Metropolitana del Valle de México 2002-2010,* (México DF: Comisión Ambiental Metropolitana, 2002), pp. 9-23.
[13] José Lezama,. "The social and political construction of air pollution: air pollution policies for Mexico City 1979-1996", (México: El Colegio de México, 1999), p.2.
[14] Ibid., p.2.

The conceptual framework of this research is based on the State-Pressure-Impact-Response (SPIR) methodology. This is a tool that can explain the existence of an environmental problem in a particular area, the reasons for its existence, the actions undertaken to ameliorate it and the policy alternatives in the case of a policy failure or inadequacy.

The analysis from the SPIR perspective starts by representing the "state" of the environment, i.e. the environmental condition to be analysed that in this case is air pollution. "Pressure" is related to the driving forces that influence and affect the state and development of the environment, taking into consideration that a lot of the pressure comes from human activities as well as from nature. Concerning human activities, the driving forces can be represented by the industrialization process driven mainly by the patterns of production and consumption, the accelerated population growth, governmental decision-making and poverty. On the other hand, driving forces concerning nature, involve geographical conditions, climate and biological processes that are linked to the human activities. The "impact" refers to the effect and result that can be positive or negative from the environment to humans, concerning the human activities as well as the direct impact on human beings, involving the quality of life, population's health and productivity. The last part of this cycle of integrated assessment is directed to the human response, concerning mainly the state of the environment, the pressure that this state of the environment causes and the effects to the human activity and eco-systems. In this sense, there exists a correlation between response and pressure that can be driven under a strategic model that can deal with the assumption that if the roots of the problems are eliminated then environmental degradation can stop or decrease and then it will be possible to achieve sustainability. It is very important for policy makers to take into consideration the actual situation of the environment and the response that is given to it. This allows a clear identification of the problem that will permit the creation of measures to control the problem. In the case of Mexico the responsibility for providing responses to the problem of air pollution is under the jurisdiction of governmental institutions such as SEMARNAT, INE, PROFEPA and CAM. As it will be discussed later, these institutions play a primary role in the policy-making process. Thus, it is particularly relevant to analyse the responses that may generate or reform national legal and political codes that form the basis of policy formulation and implementation.

SPIR forms part of a set of frameworks named PSR (Pressure-State-Response) or DPSIR (Driving Forces-Pressure-State-Impact-Response), having a social, economic, political and ecologic perspective that exemplify the purposes of the study and that will be used to support the analysis.[15]
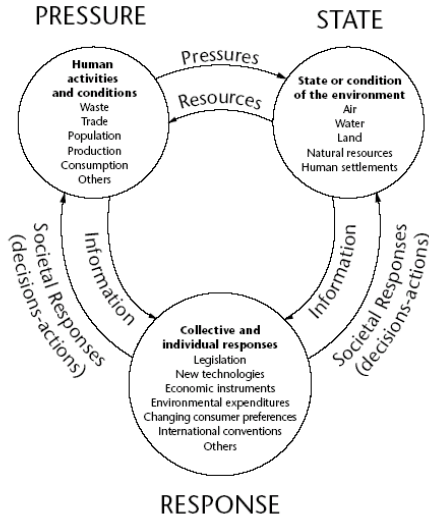
Figure 2. One example of pressure-state-response framework.
Source: Capacity Building for Integrated Environmental Assessment and Reporting, training manual 2000.

DPSIR[16] defines the different components of analysis in the following sequence:

[15] László Pintér, Kaveh Zahedi and David R. Cressman, *Capacity building for integrated environmental assessment and reporting, training manual,* (Canada: International Institute for Sustainable Development, 2000), pp. 5-6.

- Driving forces, such as industry and transport, produce
- Pressures on the environment, such as polluting emissions, which then degrade the
- State of the environment, which then
- Impacts on human health and eco-systems, causing society to
- Respond with various policy measures that can be directed by governmental institutions, such as regulations, information and taxes.

These models can contribute to the solution of the problem since they have the capacity to establish a coherent explanation of the events. This eloquence allows for the identification of the activities of each component under this framework and the correlation that each actor keeps.

In a few words, SPIR is based on a logic of causality that assumes that all human activities place pressure on the environment and affect or have an impact on the quality of the natural resources. In this situation, the society and the government will have different responses through environmental, economical and social policies, and also experience changes in perception and behaviour. SPIR has the advantage of showing these relations, providing to the general viewer a logical and integrated vision of the environment and other interconnected aspects. It is for these reasons that this conceptual framework is adopted to develop the present study due to the nature of the background that drives this thesis. Even if the analysis is directed in a political sense, there must be an interaction with the field of environmental science. Thus, it was decided to adopt this method of analysis, attempting to reach a multidisciplinary approach as well as a sustainable analysis of the problem.

The present study is primarily based on a review and analysis of the relevant literature on the subject. Direct interviews and field-work were not conducted due to the limited scope of the study. However, different policy-makers of the national environmental bureau and leading scientists on the topic were consulted. The latter include Dr. Mario Molina and Dr. Luisa Molina at the Massachusetts Institute of Technology and Dr. José Luis Lezama at the Colegio de Mexico in Mexico. Primary documentation and secondary bibliographical sources were widely utilised in the analysis. Internet-based resources were also used in the study, since many governmental and academical institutions that have programmes concerning the topic of air pollution in Mexico and important information focused on areas of interest for the study have their publications available online. The research also makes use of different statistical resources concerning the levels of pollutants with the purpose to analyse the correlation between the behaviour of the main pollutants and the designed policies and norms. National and international press was used in order to observe public perception of the problem, reflected on its media representation.

1.3 Structure of the thesis

The study attempts to develop an analysis related to the state of air pollution making an active use of the complete SPIR cycle. To this end, the second chapter provides an empirical analysis of the current situation as well as a presentation of the main effects of air pollution establishing with this the state of the environment. Since the goal of this study is to make an evaluation of the current policies the third chapter analyses different sources of pressure such as public opinion and the national policies that have been developed to reverse the negative effects of air pollution. Also, the institutional framework that deals with air pollution is presented. The fourth chapter refers to the institutional responses that have been designed to deal with the problem locally. Finally, the fifth chapter gives the conclusions and recommendations of the study.

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[16] Food and Agriculture Organization, 2004, Livestock, Environment and Development (LEAD) Initiative, "Pressure-State-Response framework and environmental impacts" (online), http://www.lead.virtualcentre.org/en/dec/toolbox/Refer/EnvIndi.htm (consulted on 01/11/2004).

Chapter 2: General Background of the state of the problem of air pollution

2.1 Scientific statement of the problem

The development of humanity, which incorporates significant population growth and technological advancement, has resulted in the creation of various environmental problems. It should be noted that this technological development has both exacerbated and created environmental problems while solving others. One of the environmental problems caused by human development is air pollution which is produced by the "presence of one or more chemicals in the atmosphere in sufficient quantities and duration to cause harm to the humans, other forms of life and materials".[17] The production of pollutants that are deposited into the atmosphere causes different effects, like acid rain or smog. Once these pollutants come to the humans through the actions of nature, like rain or wind, they affect their surrounding environment. In this sense the phenomenon is not restricted by borders and is becoming a transboundary problem with international repercussions.

The present chapter attempts to analyse air pollution in general, after which the current situation in Mexico concerning this phenomenon will be addressed. First, an analysis of the criteria that define an environmental problem will take place. Overall, it is crucial to examine whether both policy-makers and the society as such perceive air pollution as an environmental problem; this aspect will be elaborated in chapter 3. Subsequently, the general characteristics that constitute air pollution as an environmental problem will be mentioned, with the purpose to understand the problems that air pollution currently represent. A section analysing the most relevant chemical aspects of air pollution, making a description of the atmosphere, then the different contaminants and its effects and mentioning some of the most generalized measures for its control, will also be included.

The origins of many environmental problems can be linked to industrial development and underdevelopment or a lack of development. In other words all the countries around the world have contributed in different proportions to the changes that the environment has experienced through different anthropogenic activities. Hence, the environmental problems have physical and social dimensions that are directly related to the politics and the economy.

An environmental problem can be defined as "any physical change generated in the environment that is produced by the human interference, having effects that are considered unacceptable by the norms of the society".[18] Thus, when the communities complain of "environmental problems", they refer to the harm that is produced to the physical environment, caused by people and having direct consequences to the human welfare, in the short or in the long term.

2.2 Air Pollution as an environmental problem in Mexico

In Mexico, due to the fast growing population being concentrated in urban areas, there are major industrial activities, increased vehicular movement and high consumption of fossil fuels that are contributing to the environmental problem of air pollution on a daily basis. The 2002 national report of the environment in Mexico[19] mentions that the air quality in Mexico is a constant worry for the national authorities. Despite the advances achieved during the last years to decrease the rates of some pollutants, the signs of contamination are still evident, represented mainly by the lack of visibility (smog) and the increase of human diseases related to the contamination as different studies state.[20]

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[17] G.T. Miller Jr., *Living in the environment*, (Brooks/Cole, 2002), p.419.
[18] Op. Cit, P. Glasbergen et al., p.43.
[19] SEMARNAT, *Segundo Almanaque de datos y tendencias de la calidad del aire en seis ciudades mexicanas* p.155.
[20] Adrián Fernández, "La contaminación del aire, cómo abatir este problema de salud", *Ecológica*, (2001), pp. 1-6. See also, Fernandéz, Torrres, Rosales, Martínez, Muñoz, Uribe and Durland, "Evaluation of Human Exposure to Ambient PM10 in the Metropolitan Area of Mexico City Using a GIS-Based Methodology", *Journal of the Air & Waste Management Association,* Vol. 51, (2001).

This report explains that the emissions of pollutants have not only repercussions at the local level in the health of the population and in the urban environment (damage in buildings, public infrastructure and monuments) but also an impact at the regional level, damaging forestry and different ecosystems due to acid rain. These emissions produced in Mexico can also reach global levels contributing to other environmental problems like climate change or ozone depletion. It is because of these environmental problems that the Mexican government is currently taking action by creating a diagnosis of the air quality in Mexico which includes a local analysis in the principal cities of the country.[21]

Nowadays, in the Mexican society the development of technology together with increasing urbanization, population, industrialization and the use of automobiles has had an enormous impact on the environment. Mexican's attempts to satisfy their wants and needs have been driven by the concept of maximum benefit with low cost and less effort. The accumulation of the factors mentioned above and other sources of pollution have contributed to the increase of goods consumed. However, this has happened at a high social cost because this consumption has in turn produced the contamination of the environment that is damaging to human health and the survival of the ecosystems in which humans live.

In the case of many megacitites like Mexico City, the factors mentioned in the previous paragraphs represent a big problem because the phenomenon of air pollution has reached critical levels, representing radical repercussions for humans. In this sense, different authors suggest that humans, while able to live without food for more or less one month and without water for some days, they should die in few minutes if left without air. Once the air is polluted, it is as harmful as the lack of it, because instead of providing oxygen to the cells, the blood transports toxicants.

2.3 The atmosphere and air quality

The atmosphere that surrounds the Earth is divided in different thin layer of gases. These layers have different temperatures and their composition is formed by different gases.[22] This structure is comprised of the troposphere, the stratosphere and the ionosphere, each one having different compositions and concentration of gases. Nowadays, the composition of the air is about 78% of Nitrogen (N_2), and 21% of Oxygen (O_2) by volume along with small amounts of argon, carbon dioxide (CO_2), water vapor and other gases.[23] A diverse set of human activities, such as industry, transport and agriculture is changing the composition of the atmospheric components, producing a high transfer rate among the normal components and the introduction of new substances into it.

Accordingly, the pollution of the air is a consequence of natural processes as well as of human activities. According to the definition that explains air pollution as any substance in sufficient concentration in the air to produce a "harmful effect on man or in other animals, vegetation or materials"[24], the high production of pollutants that are deposited into the atmosphere, through the troposphere where they mix horizontally and vertically, often reacting with each other or with other materials, will be producing different effects. In human health these are represented through "respiratory diseases or chronic, acute and carcinogenic effects"[25]. It is like this that the phenomenon of air pollution can be constructed as an environmental problem, because the nature of the problem that is produced by human actions enters in conflict with the humans who need to understand how this problem starts and how it affects them.

In this sense there are two important atmospheric phenomena that it is necessary to mention, since they are produced in relation to contamination and are presented frequently in different cities of

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[21] Op. Cit., SEMARNAT, p. 156.
[22] Op.Cit., Miller, pp. 419-21.
[23] Moran Morgan, *An Introduction to Environmental Science*, (USA: Wiersma, 1980), p.10.
[24] Bernard J. Nebel and Richard T. Wright, *Environmental Science*, (New York: Prentice-Hall, 2002), p. 526.
[25] Op. Cit., Nebel, p. 532. See also the official page of the Ministry of Health in Mexico, http://www.ssa.gob.mx (consulted on 18/07/04).

Mexico. The first one is *Thermal Inversion* that occurs when the cold air is denser than the hot one. When over a city there is a cold flow of air, this pushes the air that is below the cold layer of air, producing a light warm up by compression. In other words, the cold air traps the air that is on the city and does not allow the exit of the produced pollutants. It is like this that more contaminated air is trapped in the lower layers of the atmosphere, producing high levels of pollution and increasing bronchial diseases in the citizens, particularly among the children and the elderly.[26] This phenomenon can have terrible consequences if it lasts for some days producing a contamination crisis in a city. In Mexico City 10 thermal inversions were registered in 1991 when Mexico City metropolitan area registered 170 days as being above the danger level on air pollution indexes, more than any other time in the city's entire history. According to Martin Becerril, from the Allergies and Immunology Department of the La Raza Medical Centre of the Mexican Social Security Institute, "at least 10% of the population suffers from respiratory diseases such as pulmonary asthma". [27]

The second important phenomenon that this study refers to is *Photochemical Smog*. Smog is well known as a brown or grey layer that is visible in many cities of the world. In this case it is very notorious in Mexico City, and it is necessary to take into account that the geographical conditions of this city being in a valley let the smog cloud to be evident. There exist some kinds of chemical reactions that take place due to the presence of light and that are known as photochemical reactions. In a contaminated atmosphere a lot of photochemical reactions occur, which produce very toxic products that even in very small proportions such as 1 mg/m^3 can be harmful. For the photochemical smog to be formed, the mixture of oxides of nitrogen, hydrocarbons and light is needed, which can generate the peroxyacyl of nitrates, known as PAN. The process of their formation starts due to the light that breaks a link in the NO_2. In this sense, NO_2 absorbs light and splits to form nitric oxide and atomic oxygen. In sunlight the atomic oxygen combines with oxygen to form ozone (O_3). If no other factors are involved, ozone and nitric oxide react to form nitrogen dioxide and oxygen gas.

Cars play a very important role in producing hydrocarbons and oxides of nitrogen, which then lead to the formation of photochemical smog.[28] However, in the case of Mexico City, even if transport plays an important role to the development of smog, a chemical study developed in 1995 by the University of Irvine in California showed that heating gas used as a quotidian energy source by many Mexican families produced half of the emissions of the hydrocarbons in the air of the city. The study mentioned as well that the annual emissions of unburned liquefied petroleum gas (LPG) are comparable to those of volatile organic compounds (VOC's) from the industrial and vehicular sources.[29] Concerning this topic, Mexican authorities represented by Claudia Sheinbaum from the Secretariat of Environment and Natural Resources, Federal District Government, accept the failure in achieving proper policies to design substitution programs concerning LPG apart from the fact that there have been no actions that evaluate the real damage that LGP produces.[30]

2.4 The principal air pollutants and their sources

There is a classification of the major pollutants as primary and secondary pollutants. The first class is a substance in "harmful concentrations" that has been added directly to the air and can be a natural component of the air like carbon dioxide, that raises above its "normal" concentration, or it may involve the addition of a chemical not present in normal air. The second class is formed in the atmosphere through a chemical reaction involving normal or abnormal components of the air. [31] In figure 3 is the representation of these pollutants, their emissions and impacts.

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[26] Op. Cit. Nebel, p.529.
[27] Peter Gellert, "Mexico City: for half the year, don't breathe" (online), Green Left Weekly http://www.greenleft.org.au/back/1992/40/40p16.htm (consulted on 19/10/2004).
[28] Op. Cit. Nebel, p. 527.
[29] G. Parkinson, "Heating gas, not gasoline is the major source of Mexico City's smog", *Chemical Engineering Review*, Vol. 83, No. 2, (1995), p. 50.
[30] Massachusetts Institute of Technology and Colegio de México, *Integrated Program on Urban, Regional and Global Air Pollution: Mexico City case study, Fourth US-Mexico,* Joint Workshop, Report, (Massachusetts: MIT, 2001) p.4.
[31] C. Quigley, "Our Ecological Crisis", *Current History*, (1970), pp. 1-12.
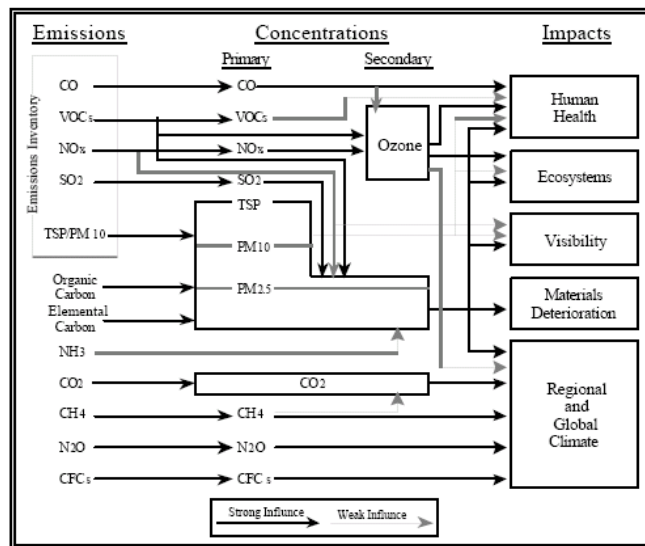
Figure 3. Influences that connect emissions of pollutants to ambient concentrations to impacts. Weaker influences are shown with gray lines. The area of the TSP box is divided into PM_{10}, $PM_{2.5}$, and primary and secondary components, with area roughly representing the relative mass.[32]

Oxides of carbon (carbon monoxide CO, carbon dioxide CO_2): The most harmful of these two compounds is CO. It is a lethal poison when it interferes with the transport of oxygen in the cells of the organism. A concentration of 30 ppm of CO for eight hours is enough to produce severe headaches and vomiting. In big cities it is normal to find extended levels of 30 ppm or higher in the congested streets, as one of the sources of CO is car emissions. Miller states that about 93% of the CO in the atmosphere comes from natural sources, particularly the oxidation of methane or "marsh gas" emitted by decaying matter in marshlands. It can also enter the atmosphere as a result of incomplete combustion of carbon containing fossil fuels, especially in the internal combustion engine. In humans it can cause in low exposure headaches and fatigue in moderate concentrations of 50 to 100ppm. In high exposure it can cause headaches, dizziness and coma with concentrations of 250ppm and can result in death with concentrations of 750ppm or more. [33]

When cars are not required to control the reduction of the emissions of CO, they emit 30 grams of CO for each 100 litres of gasoline burned.[34] A massive intoxication occurred in Mexico City in 1982 when hundreds of cars attempted to leave an underground parking garage. The emission of CO and the slow payment system produced what could have been a catastrophe (fortunately nobody died). The threat was partially alleviated when the personnel let the cars go without paying after seeing signs that people were becoming ill. A lot of people showed signs of intoxication and were registered at the Medical Centre of the Mexican Social Security Institute. Since then there is a rule that does not allow the drivers to run their engines in closed areas.

CO_2 is the major pollutant in the atmosphere. Its effects are not particularly serious as the ones produced by the CO, as it forms part of the natural cycle and is possible to prevent it from causing any acute problem concerning contamination. However, if the levels of CO_2 continue rising, they can produce other important environmental problems, such as climate change.

Since transport systems are the main contributors to the production of these pollutants there have been different measures taken with the aim to decrease the impact of this sector on the environment, as well as on humans. Some of these measures are the redesign of carburettors, catalytic

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[32] Luisa Molina and Mario Molina, *Air Quality in the Mexico Megacity: an integrated assessment*, (Cambridge: Kluwer academic publishers, 2002), p. 13.

[33] The description of the pollutants such as SO_x, NO, HC are based on Miller, *Living in the Environment,* pp. 422-424.

[34] Gobierno del Estado de México, *La atmósfera y la contaminación del aire,* (online), http://omega.ilce.edu.mx:3000/sites/ciencia/volumen2/ciencia3/097/htm/sec_11.htm (consulted on 21/09/2004).

converters, air bomb injection and engines that work with lead free gasoline. In the case of Mexico City, the height over the sea level is 2.240m which means that the quantity of oxygen for each cubic meter of air is reduced form 275g to 212g.[35] Car engines are designed to work at the sea level and the reduction of atmospheric oxygen affects proper functionality, thus further contributing to air pollution. According to SEMARNAT, it is estimated that the pollution produced by 2.5 millions of cars in Mexico City is equivalent to the one that could be produced by 6.3 millions of vehicles at the sea level.[36] These facts led to new initiatives, such as the programme "one day without driving," that will be explained in chapter three.

Acid Sulphur oxides (sulphur dioxide SO_2, sulphur trioxide SO_3): SO_x according to Miller are the acrid, corrosive, poisonous gases. In the case of SO_2 even if it is a normal component in the air, its rates have increased and are still rising slowly, which is likely due to the burning of fossil fuels. Part of SO_2 comes from volcanic eruptions; the other part comes from human activity like the burning of fuels with high levels of sulphur, the extraction of metals with sulphur and the production of sulphuric acid. Recent studies show that in Mexico City the pH of all the water is 5.5, a minor level. This value is representative in the sense that it does not show a clean atmosphere. Due to the atmospheric pollution, sometimes it may rain acid instead of water over the city. SO_2 can be in the atmosphere in short terms, but under the presence of oxygen and light it is transformed into SO_3 , a dangerous component that once in contact with the water produces sulphuric acid that is highly corrosive. With the rain, SO_2 and SO_3 are deposited into rivers and oceans in the form of acids, and with this process the acidity of these waters increase. Other targets of its effects are aquatic life, plants, animals, urban surroundings and human beings, especially children and elderly people.

Nitrogen oxides (nitric oxide NO, nitrogen dioxide NO_2): NO_x according to Miller are reddish-brown gases with a pungent, choking odour. Sulphur dioxide and nitrogen oxide, emitted by industrial smokestacks and automobiles, turn into diluted sulphuric and nitric acid, or acid rain, when they come into contact with moisture, and also fall as acid gas and particles. Among the oxides of nitrogen the most important one is the NO_2 that is produced once NO reacts with oxygen. NO is not considered harmful to the human health. However, NO_2 has important repercussions for the lungs becoming an important contributor to acute respiratory diseases in children and asthmatics, apart from representing a source of acid deposition in the nature, destroying buildings and vegetation, killing fish in lakes and polluting groundwater.

Hydrocarbons HC (methane, butane, benzene, and ethylene): HC according to Miller are a class of organic compounds containing carbon and hydrogen. In the air they are released by mainly unburned or partially burned gasoline and evaporated industrial solvents, especially from refineries. Humans produce only 15% of the total global emissions of hydrocarbons but build abnormally high concentrations in urban air, which typically contains 50 to 200 different hydrocarbons. The main problem with these contaminants is their role in forming photochemical smog; however, there is also the component benzene that is proven to be carcinogenic (its inhalation produces death by cancer in laboratory rats).

Photochemical oxidants (Ozone O_3, PAN): O_3 according to Nebel is a harmful component that is produced by electrical engines. It is mentioned that O_3 is formed in the atmosphere due to photochemical reactions, and is a secondary pollutant. O_3 is highly toxic to plants and animals, and also damages lung tissues being implicated in many lung disorders. For these reasons it is considered that ground level ozone is a very serious pollutant. In recent studies it has been discovered that some compounds produced by humans reach the stratosphere and can destroy the ozone layer. The chlorofluorocarbons have been used in liquids for refrigerators or in aerosols. Since they are very volatile, they stay from 10 to 30 000 years in the atmosphere, and can reach the stratosphere where the ozone layer is located. There, a photochemical reaction takes place that produces chlorine, which is in turn responsible for damaging the ozone layer.[37]

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[35]Op. Cit., Nebel, p. 525.

[36] Op. Cit., SEMARNAT, *Segundo Almanaque,* p.10.

[37] Thad Godish, *Air Quality*, 2nd ed., (New York: Lewis publishers, 1991), p. 48-53.

Particulates (smoke, soot, dust, asbestos, metallic particles, oil, spray, sulphate salts, fluoride): When small particles go into the air, a process of acceleration takes place. However, due to an action of resistance these particles reach a constant speed, named terminal speed. The smaller the particle, the lower its terminal speed. These fine dusts are suspended in the air.[38] Once the action of breathing takes place in humans, particles enter the body; however, the human body is able to eliminate large proportions of them thanks to the respiratory system. The major proportion of particles is stopped before reaching the alveolus. Nevertheless, the ones that have diameters less than 5mm can reach the alveolus and are deposited. Some cells move to trap the foreign dust and transport it to the lymphatic nodes. The particles can be dissolved in the cellular liquids and are distributed around the organism, but if they are not processed they remain in the lungs or in the lymphatic system producing respiratory and cardiac problems, especially when the particles contain silicon or metals. It is due to this key fact that we should avoid emitting pollution of particles with minor diameters of 7µm. [39] According to different studies made in different countries, including Mexico, it is estimated that the risk of death in early ages increases by 2% for each increment of 10µgr of PM_{10}.[40] These particles are especially harmful for the health of the population because they can reach the deepest parts of the lungs.

Nebel explains that lead and other heavy metals are very dangerous at low concentrations and can cause brain damage and death, impair many tissues and organs, and also affect the central nervous system. The human body succeeds in expelling 230µm of lead each day; however, if the quantity that enters in the body is greater, then it accumulates and produces intoxication.[41] Its presence in the atmosphere is primarily due to the burning of gasoline. Currently, in many countries as well as in Mexico, relevant measures are taken, especially through the production of unleaded gasoline.

Lead pollution is a special case in Mexico as could be seen when significant levels of the contaminant were detected in Mexico City in 1992 coming from fuels. At that time, several governmental programs were already taking place to decrease the levels of lead in gasoline. Despite the fact that these programs decreased the amount of lead emissions significantly, two million tons of lead were still emitted, indicating the partial success of the governmental policy.[42]

The official political discourse is used to communicate the significant improvements in air quality made through the different actions taken. If the contamination decreases, then it is said that the political measures work; in the opposite, if the contamination increases it is said that the political measures fail. However, in both cases the political discourse fails to recognize the magnitude of the increases and decreases, no matter whether they are still harmful to the human health. In other words, there is a bias in favour of boosting political reputation as opposed to making commitments which are truly meant to improve the state of human health and environmental protection. It is assumed from the political perspective that the same attitude towards the health of the population includes the solution to the environmental problems and can be linked to the problem of air pollution. A indication of this is what the Government established as a challenge in its national programme of environment 1995-2000 mentioning that

> …it is necessary to evaluate in quantitative sense the air quality, through the measurement of the levels of contaminants in the air, that can present significant repercussions in the health of the population. By comparing these measures with the international and national norms it can be determined if the quality of

[38] Ibid., p. 154.

[39] Secretaría del Medio Ambiente del Departamento del Distrito Federal, México y el Instituto Nacional de Salud Pública, *Donde causa daño? Respuestas a preguntas sobre contaminación y salud,* (México DF: Arma, 1996), pp. 28-31.

[40] Ibid., p. 30.

[41] Ibid., p. 20.

[42] José Lezama, *Aire Dividido: Crítica a la Política del aire en el valle de México*, (México: El Colegio de México, 2000), p. 3.

the air is satisfactory or not and in this last case establish control programmes according to the severity of the problem…[43]

On the other hand, there is the need to evaluate what the population thinks and to create properly designed programmes according to the real needs of the population. This is primarily impacted by corruption, an aspect that lies outside the scope of the present study.

In Dr. Molina's words, the currently situation concerning the state of the environment in Mexico is that

> There is still a long way to go but at least certain pollutants have been controlled to a very significant extent, for example, lead. Mexico City used to have leaded gasoline and so the levels of lead in the blood streams of children were just too high. But the government was able to replace leaded gasoline with unleaded gasoline so that part of the program is under control. Carbon monoxide and sulphur dioxide are two other pollutants that are essentially under control - their concentrations have decreased very significantly. But what remains, the two pollutants that are very difficult to control and are still very worrisome from the point of view of the health effects, are ozone and small particles PM_{10}- these particulates that can damage the health of human beings because they penetrate deeply into the lungs.[44]

Some illustrative figures provided by SEMARNAT concerning the situation of the environment in the last years are presented here.
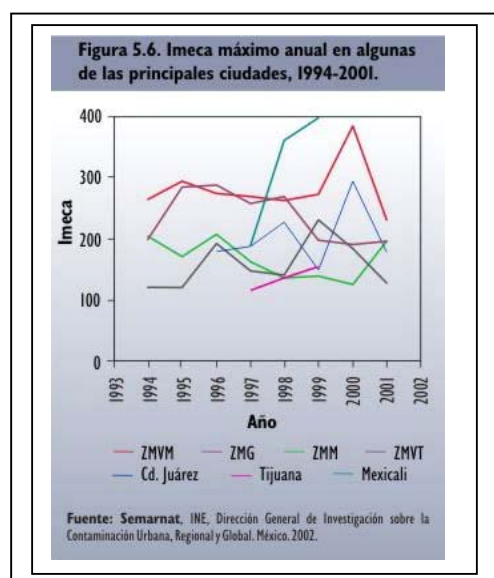
In figure 4 taken from SEMARNAT[45] the problem of air pollution in the main cities of the country is evident. These cities are Mexico City (ZMVM), Guadalajara (ZMG), Monterrey (ZMM), Toluca (ZMVT), Cd. Juárez and Mexicali. From 1994 until 2001, the tendency of the maximum annual standards that are 100 IMECA points according to the air quality NORMS (Norma Oficial Mexicana, Mexican Oficial Norm) are violated. Mexico City and Guadalajara have the highest values. All of the cities apart from Cd. Juarez and Monterrey have a decreasing tendency. This figure shows a general picture of air pollution in which a holistic perspective of the pollutants is represented. The IMECA index, the NORM and further information about the main pollutants in Mexico will be presented in the next chapters.

Figure 4. Maximum annual IMECA in some of the main Mexican cities 1994-2001. Source: SEMARNAT, INE, General direction of research concerning urban, regional and global pollution. Mexico 2002.

Figures 5 and 6 present the main pollutants in Mexico: O_3 and PM_{10}. All the cities violated the maximum standards of the air quality NORMS at least once a year. O_3 is the principal problem in Mexico City (ZMVM); however, if this tendency is compared with the period of 1990-1994 it has decreased. The situation is not the same for PM_{10}. In ZMVM the percentage of emissions has decreased in the last three years. However, Guadalajara and Monterrey increased their emissions. The tendency that Monterrey presents is critical. In 1995, according to the national report of emissions designed by SEMARNAT, this city is the principal emitter of particles in the country. It is possible to observe that its tendency is still increasing.

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[43] INE, *Gestión de la Calidad del Aire en México, Logros y retos para el desarrollo sustentable 1995-2000*, (México DF: INE, 2000), p. 7.

[44] Molina, 2002, quoted in http://www.pulseplanet.com/archive/Jul03/2977.html (consulted on 28/10/04).

[45] SEMARNAT, *Segundo Almanaques* p. 160.
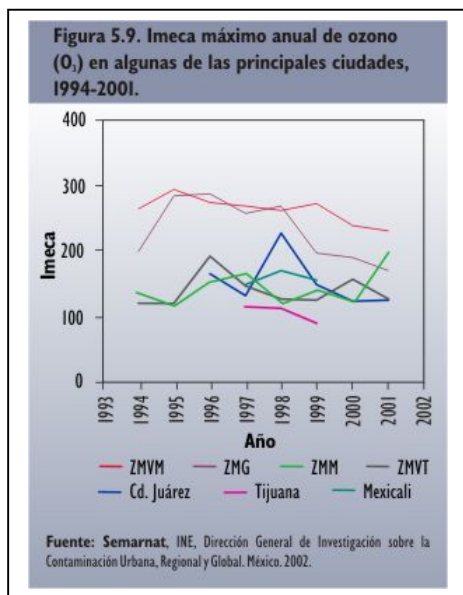
Figure 5. (Figure 5.9) Maximum annual Imeca of ozone (O_3) in some of the principal Mexican cities 1994-2001. Source: SEMARNAT, INE, General directorate of research concerning urban, regional and global pollution. Mexico 2002.
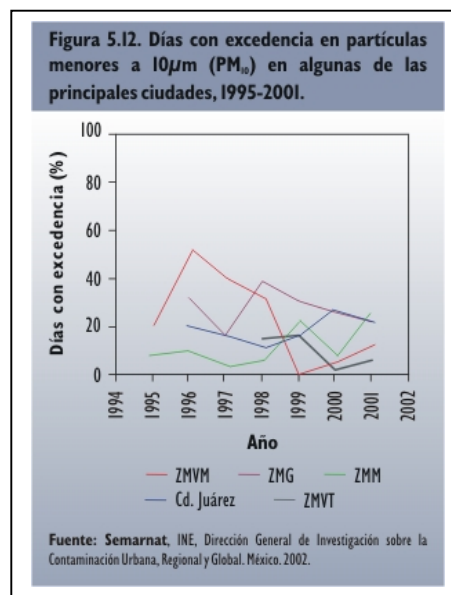
Figure 6. (Figure 5.12) Days with over levels of minor particles of 10 µm in some of the principal Mexican cities, 1995-2001, (PM_{10}).Source: SEMARNAT, INE General directorate of research concerning urban, regional and global pollution. Mexico 2002.

This chapter exposed the causes and consequences, as well as the factors that contribute to urban air pollution and are related to the case of Mexico. The purpose is to highlight the reasons that generate a political process behind this environmental problem, which will be presented in the next chapter.

Chapter 3: Socio-economic pressure and policy-making process

3.1 Mexico and its policy transition

In the last decades, the environmental policy-making process in Mexico has passed through different transformations concerning environmental policy-making. This can be characterized by its internationalisation concerning different topics, related to the state of the environment. Aiming to define and develop different important global non-binding multilateral agreements, action plans like Agenda 21 and established instruments, the national government has developed different actions to reach sustainable standards of development. Influenced by the Mexican participation in the international arena and the development of environmental problems in the country, policy-makers have developed legal, policy and institutional reforms aiming at creating new mechanisms of information and control of environmental problems, education and citizen participation. National institutions, norms, regulations, legal instruments and national measures have been modified to implement environmental policies, especially in the case of acute problems, such as air pollution. The conservationist ideology dealing with the extinction of rare species and the preservation of nature, and the ideas of ecological and sustainable development have also played a crucial role in gathering public attention and pressure for new policies.

The aim of this chapter is to analyse the role of different socio-economic factors that have influenced, through their pressure, the policy-making process and outcome of the governmental efforts to tackle the problem of air-pollution. The situation in Mexico and Mexico City has been previously mentioned without any detailed explanation of their internal political structures. The study will primarily focus upon the Federal Mexican government and the government of the state of Mexico (Figure 7). The latter, known as EM from its Spanish acronym (Estado de Mexico) incorporates the suburbs and counties that are included in the Mexico City Metropolitan Area (MCMA) and the Federal District or DF (Distrito Federal) that involves the central part of Mexico City. [46] Firstly, the general background of environmental policies in Mexico will be presented, with special reference to the air pollution-related policies. Subsequently, the institutional framework is explained with the purpose to understand which institutions are responsible for dealing with air pollution in Mexico.
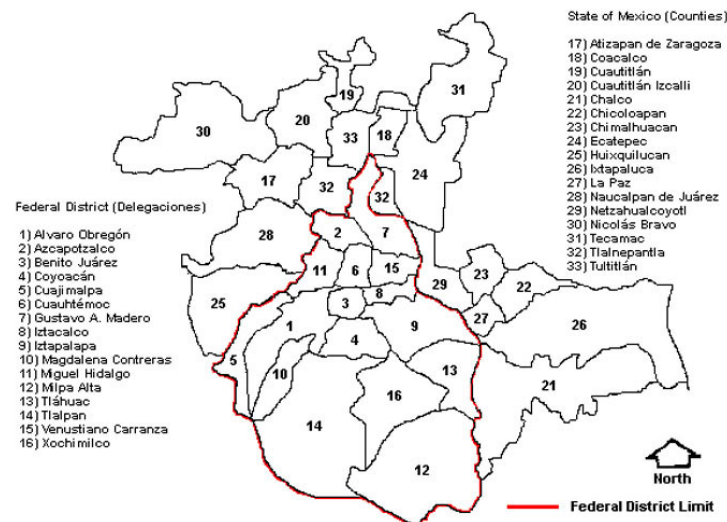
Figure 7. Mexico City's Metropolitan Area
Source: http://www.sbg.ac.at/ipk/avstudio/pierofun/mexico/air.htm#Mexico

3.2 Policies and environment in Mexico

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[46] The Mexican Republic is formed by 31 states and the DF. Among the states of Mexico, one named EM is situated in the centre of the country surrounding the DF. The DF and some counties of the EM form the MCMA. The DF is divided into 16 counties called "Delegaciones" and all of them constitute the MCMA. From the total of 121 counties of Mexico, only 16 of them are considered part of the MCMA.

The current transition that the Mexican environmental policies have been going through concerning their planning and design, has not received widespread attention compared to other socio-political processes. Overall, the theoretical developments concerning the environmental politics in Mexico have been very slight. However, through the policy process specific political actions have been developed in response to environmental problems like air pollution. According to Carter there are different factors that contribute to a policy transition in any system. These are: sudden crisis, which leads to new problems and therefore to new solutions that with external relations will promote new social movements and leadership or despotic power of certain groups, which in turn will develop the new policy making transition. In Carters' words, social situations that require a solution "may cause disarray and pressure in a policy community producing immediate local improvements in the safeguards". [47] Thus, those social situations will represent a new problem, which will force policy-makers to look for alternative policies in their attempt to solve the problem. Therefore, it is necessary to remember that this policy transition for the case of Mexico has been deeply influenced by international agreements, action plans and trade agreements like NAFTA, Agenda 21, Kyoto Protocol and others that have encouraged the national government to modify its policies.

Another factor that influences political change includes the actors that have the capacity and pressure to use their power to influence the modification of policies according to their interest. These actors are mainly represented by the industrial sector. Elliot mentions that the multinational corporations (MNCs) are big contributors to the environmental degradation in certain countries. Behind this fact is that the MNCs are economically powerful, and therefore are able to influence the political process in a disproportionate manner.[48] Interestingly, international and national companies in Mexico have increased their interest to participate in the field of air quality. The subject of study related to this industrial behavior could be developed into a separate thesis project on its own, and for this reason it is not studied in depth as a part of this research.

Thus, the design and development of certain policies corresponds to the network of power between different social actors and the pressure they impose to the system. In a general perspective, policies are a collective learning process to increase the capacity to solve problems.[49] Downs mentions that the attention to the social problems and the policy-making process corresponds to a cycle that starts when a problem is recognized. This continues to a stage of high enthusiasm to solve it in the short term and then there is a decrease in the public interest, reaching many times the complete disappearance from the collective memory often without solving it. In other cases, there exists a social adaptation to the problems converting them to a natural way of living.[50] This situation is very acute concerning environment problems, because this kind of problem must avoid the collective disinterest, as well as needs to receive rapid actions in a collective sense. According to Lezama, this is the case of air pollution in the case of Mexico City where the population nowadays experiences the air pollution as part of their daily life. To listen to the contamination report in the mornings is the equivalent to listen to the weather report in other countries.[51] Thus, an environmental problem that at the beginning of its discovery caused shock in the society and produced social mobilisation seems to have become an internalized way of living and is perceived as a phenomenon that is inevitable. In addition, the repercussions in the health of the society and its natural surroundings are perceived as something "normal."[52] Despite the public numeric indicators that illustrate air pollution levels, neither the Government, nor the society, show an apparent interest in solving the problem. In this respect, Lezama perceives a weakness in the governmental programs once the norms are violated and in the scarce will

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[47] Neil Carter, *The Politics of the Environment: Ideas, Activism, Policy*, (Cambridge: Cambridge University Press, 2001), pp. 184-186.
[48] Lorraine Elliot, *The Global Politics of the Environment,* (London: Tavistock and Rochdale, 1998), p.123.
[49] Timothy Doyle and Doug McEachern, *Environment and Politics,* 2nd ed., (London: Routledge, 2001), pp. 11-13.
[50] Anthony Downs, *El Ciclo de la atención a los problemas sociales*, in Vicente Aguilar, *Problemas Políticos y Agenda de Gobierno*, (Mexico DF: Miguel Angel Porrúa, 2003), p. 10.
[51] Lezama, *Aire dividido*, p. 10.
[52] CEPAL, *Contaminación Atmosférica y Conciencia Ciudadana*, (Santiago de Chile: CEPAL, 2003), p. 234.

of the society to demand clear air.[53] Due to the importance of the social participation in the recognition of environmental problems, this point is stressed in the next section that is devoted to the manner in which Mexicans perceive the problem of air pollution.

In the Mexican political process, economic structures, class conflict and interest groups have a direct influence on the formation of policies and on political power in general. This process focuses primarily on the implementation of a decision, rather than carefully examining the rationale and the driving forces behind the problem that led to that decision. In this sense, the bureaucratic process is fulfilled, but the social actors and their participation are ignored by the policy-makers. In the case of air pollution in Mexico, it can be recognized that the partial success of some programmes designed by policy makers aiming to decrease air pollution, is due to the lack of perception behind what is producing the health problems in the population. These policy makers must design policies, which fulfil more than the bureaucratic[54] process by implementing tools that only work in the short term.

However, even if changes such as the creation of new norms, regulations, legal instruments and measures are taking place in the policy-making process in Mexico, there is evidence that shows that this path is not followed properly and that there are other driving forces that deal with the political transition that the country is experimenting. According to the UNEP (United Nations Environment Program), in a recent report concerning the state of the environment in Mexico, the organization qualified the Mexican environmental policies as "disastrous." The UN agency pointed out that the environmental damage in Mexico is evident and that the governmental budget that is assigned to this sector is insufficient. Klaus Töpfer mentioned that "policy makers in Mexico have the responsibility to provide solutions to different environmental problems, like poverty abatement and air quality improvement."[55] This idea was supported by many NGOs that wrote to President Vicente Fox demanding a change in the way environmental policy in Mexico is directed. They state that

we would like to mention that the Mexican environmental policies designed in the actual administration have shown a notorious decrease in their effectiveness; first, the substitution of experts in the field of environment by politicians and decision-makers that are completely inexperienced in the field; secondly, the design of policies that satisfy the interest of groups and that are designed to work in a short term, sacrificing the natural resources. These resources currently represent the subsistence and the environmental heritage of all the Mexicans and the future generations.[56]

Moreover, the NGOs demanded that the Fox administration

should correct the way in which the politics of Mexico are designed, and that the policy making process in this field should have a scientific and legal base. Recommendations given by the experts should be taken in account, as well as the demands of the society. Collective interest and sustainability should be made the priority over short term economic interests which are primarily responsible for much of the actual environmental damage that the country is experiencing.[57]

Four years ago, the current administration established a mandate which included promises to improve various environmental problems. However, these promises have been left unfulfilled. This has been confirmed by UNEP, which has said that "with the signature of international agreements Mexico has made efforts to conserve its natural resources…however, the application of the recommendations given by these environmental agreements has not been fulfilled". [58]

Governmental institutions play an important role in the design of programmes, and the implementation of norms and rules and the development of policies. In the case of air pollution even if

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[53] Op.Cit. Lezama, pp. 2-5.
[54] The meaning of bureaucratic process refers to the inefficiency of the policy makers to generate effective actions in order to solve problems and the substitution of these actions by symbolic, self-serving activity.
[55] Greenpeace México, news 26-07-2004, http://www.greenpeace.org/mexico_es/news/details?item_id=548366 (consulted on 04/10/04).
[56] Ibid.
[57] Ibid.
[58] Ibid.

a key segment of the population gets to have a "natural perception" of the problem, other social groups have remained active which has in a sense forced governmental institutions to include the issue in their agenda. Besides this, different policy makers claim that there exist different institutional problems such as a lack of coordination and communication, a lack of long-term planning and little value attached to environmental agenda. There are also problems with transport and urban planning, which can be linked to the poor relationship that exists between the academia and the policy-makers. This is confirmed by Victor Lichtinger, ex-secretary of SEMARNAT, who has said that

> …the institutional capacity is very important as well as the science component. In many megacities in Mexico, there is a tendency to have metropolitan authorities, but it is difficult to coordinate with different party ideologies, weak institutions and changing parties/personnel. There is a need to move forward to build stronger institutions for air and other critical environmental issues. The metropolitan authorities need to be stronger to create and address long-term issues with sound scientific knowledge…[59]

It is important to point out that environmental problems like air pollution require clear strategies in the policy-making process to confront the problems of institutional coordination that are related to the lack of organization of the policy-makers. This lack of coordination can be misunderstood and can be seen as a result of a lack of interest to solve the problems, as well as the omission of responsibilities. This lack of clear strategies demonstrates how a system where the economic interests are very powerful push aside important areas like policy-making concerning the environment.

3.3 How Mexicans perceive the problem of air pollution?

As it was mentioned in different sections of this study, the actual perception, acceptance and behaviour towards air pollution from the society plays an important role in the success of the programmes implemented by the national government to decrease or solve the problem of air pollution. During the last decades, different programmes aiming to solve the problem of air pollution have been designed. The programme PROAIRE[60] is one of them and at some point this program invites the society to participate in the solution of air pollution, since it is recognized that if humans are responsible for the creation of air pollution, they should participate in the solution of the problem as well.[61]

It is important to mention that the National Program of Environment and Natural Resources 2000-2006 established that through the public consultations the design of the environmental agenda, which includes air quality, was deemed to be satisfactory. However, this is not so clear in reality as the design of programs fails to fulfil the needs of the society. This is evident concerning the good "will" of the government at the beginning of the new presidential period, to include the demands of the society in its platform. Yet, once enough time past, Fox's actions did not correlate to his initial guarantees.

This situation can be explained through a study realized by Roberto Muñoz, vice-chairman for analysis and information of the monitoring atmospheric system in Mexico City. As part of the study, a survey of 4,000 residents in Mexico City was conducted concerning the air-quality in the city. This survey showed that 30% believed that the reason the government designed programs to abate the problem of air pollution was mainly self-serving. More than 30% thought that the government's online air quality reports were disingenuous.[62] Also, responding to another question, 40% of the people could not identify any of the government's programs to improve air quality, and the rest considered that the programs that are now taking place are restrictions to the population more than preventive measures. In this respect the research could prove that people get to link the quality of the air through their own

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[59] Op. Cit., Massachusetts Institute of Technology and Colegio de México, pp.4-5

[60] Further analysis concerning responses to air pollution is presented in chapter 4 where a detailed description of PROAIRE takes place. At this stage, it should be mentioned that PROAIRE is a programme designed by the Mexican Government to deal with air pollution in different megacities of Mexico.

[61] Op. Cit., Hibler, p.2.

[62] Centro de Control de la Red Automática de Monitoreo Atmosférico, http://148.243.232.103/imecaweb/ (consulted on 28/10/04).

experience, and do not show interest for the official information that is provided by the programmes that are monitoring the quality of the air. The lack of trust in the policy-making body is clear. Muñoz in this respect mentions that "if people see the mountains, they say it is a good day. If they can not see them, then say pollution is high"[63] This can be understood as well in the words of Herzlich who mentions that the social representation of health is linked to clean air.[64] As a result, people do not recognise their responsibility concerning the problem of air pollution, attributing it to other sources, such as factories. However, few people recognised that vehicles are high emissions contributors. At times, they also thought that the source of the problem is located at a far distance from them. Muñoz received claims such as, "other people are mainly responsible: my neighbours, maybe, but no me, not my car. My family and life style are not to blame"[65] The study showed that in general, people do not have the will to sacrifice their lifestyles to decrease the problem. Muñoz points out that "it seems that the social participation is limited to complying with programs"[66] This study concludes that even if people recognise the fact that air pollution damages their quality of life and their health, they do not act to solve or decrease the problem. It is possible to mention that the information that people need to receive from the government about invisible pollutants such as the O_3 and PM plays an important role in the cultural acceptance of the problem as well as in the implementation of the solution.

To sum up, there is a lack of communication between the policy-makers and the society concerning the design of programs to solve the problem of air pollution. The case of Mexico City is a representative case of what is happening in general in the megacities of Mexico where governmental programs like PROAIRE are taking place (Guadalajara, Monterrey, Toluca, Ciudad Juarez, Puebla).

3.4 National governmental institutions dealing with air pollution

The development of the national environmental agenda in Mexico guided by the National Government has been in constant transition. It is important to examine how this transition has progressed and how the relevant institutions have evolved. The design of the environmental agenda had been the responsibility of different sectors from 1917 until 1976. This process took place since the Law of Control and Prevention of the Environmental Contamination appeared with a sanitarian approach under the Secretariat of Health Regulations and Assistance (SSA). In 1976, a more urban focus was developed in this agenda, which as a consequence led to the creation of the Secretariat of Human Settlements (SAHOP) which was the agency responsible for coordinating this portfolio. In 1982, the environmental agenda was passed to the Secretariat of Urban Development and Ecology (SEDUE) with the creation of the Federal Law of Protection of the Environment.

Then, with the creation of the General Law of Ecological Balance and Environmental Protection in 1987, the topic of conservation of species was introduced becoming the responsibility of the Secretariat of Social Development (SEDESOL) that substituted the SEDUE. In 1994, a social environmental approach was developed on the premises of the national environmental agenda. Therefore, there was no agency that could deal with this new responsibility and for those reasons the Secretariat of Environment, Natural Resources and Fisheries (SEMARNAP) was created.

In other words, the government of Mexico tried several organizational approaches to solve environmental problems in the following order:

1970s: Environmental issues were part of Health Ministry.
1982: Environment moved to SEDUE (ministry of urban development and ecology).
1992: Environment moved to SEDESOL (ministry of social development)

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[63] Roberto Muñoz, quoted in Hibler, "Taking control of air pollution in Mexico City" pp. 3-4.
[64] Claudine Herzlich,, "Les représentations sociales de la santé et la santé en mutation: un regard rétrospectif et propsectif sur la fécondité dans d' un concept", in F. Buschini and N. Kalampalikis (eds.), *Penser la vie, le social, la nature mélanges en l'honneur de Serge Mosovici*,., (Paris: Edtions de la maison des sciences de l'homme, 2001), pp. 189-200.
[65] Ibid, p.190.
[66] Ibid, p.191.

1994: Environment and natural resources functions combined into a single agency called SEMARNAP (Secretariat of Environment, Natural Resources and Fisheries)

2000: Newly elected president Vicente Fox pulled fisheries out of SEMARNAP, and renamed the agency SEMARNAT.[67]

Hence, since 1994 Mexico has had a Secretariat or Ministry that specifically deals with subjects related to environment and natural resources. Since then, the administrative, legal and programmatic framework of the national environmental agenda has been designed to deal with environmental subjects in the federal, national and in some case regional level. Furthermore, different mechanisms have been developed to improve the environmental management in Mexico.

The SEMARNAT is one of the few national institutions that have different national, thematic and regional consultative councils. One of them is the National Consultative Councils for the Sustainable Development (NCSD), established in 1995. The NCSD consists of one national and four regional councils, integrated by representatives from different sectors of society, including the private, legislative, academic, governmental and non-governmental sectors. [68] Some of the actions that these councils have promoted are seminars in environmental education and qualification for sustainable development. The participation of the Consultative Councils for the Sustainable Development in the decision-making takes place on diverse subjects related to this institution. SEMARNAT has been very productive and has registered important advances since 1995. One example is the reform of the General Law of Ecological Balance and Protection to the Atmosphere (LGEEPA).

However, even if one of the objectives of the NCSD is to promote social participation in the development of the national environmental policy, it has faced great difficulties in carrying out its actions that are established from theory to practice. It has not been an easy task to reach social participation and to form consensus over the representatives of the society and their relation with the SEMARNAT. Initially, it was thought that the social, the non-governmental, the academic and the industrial sectors should be part of the council. Afterwards, the NCSD included the representation of local congresses and in recent times it has incorporated the native representation, as well as the gender perspective. There is also an intention to include representation of other groups, such as the youth. It is important to note that the variety of groups that are included in this council causes great difficulty in the formulation of environmental policies due to the diverse set of interests involved.

The SEMARNAT has two sub-agencies that have the responsibility to deal with the topic of air pollution at a national level. The first is the National Institute of Ecology (INE - Instituto Nacional de Ecología). INE is a decentralized body of SEMARNAT. This institution was created in 2001, with the purpose of promoting and coordinating research on environmental issues, of providing data, ideas, proposals and technical input to decision-making in support of the management and administration of natural resources and the environment. Its mission is the generation of scientific and technical information concerning the environment.[69] It is dedicated to ensure that the general environmental policy of Mexico is based on a proper scientific and technical knowledge to reach its objectives. To achieve this aim, INE divides its work into different "scientific agendas."

The first is the "green ecology agenda" that deals with research that concerns the area of sustainable natural resource use, such as conservation of biodiversity, land use planning and watershed management. The second is the "brown ecology agenda" that works with pollution control, establishing measures at local, regional and global level. Its main purpose is to reach the development of efficient research that provides tools to establish efficient policies that prevent pollution. The third one, the "socio-economic agenda", deals with research dedicated to discover and manage economic instruments for environmental policy. The fourth is the "experimental research and training agenda"

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[67] Mexico City Organization Fact Sheet, http://msl1.mit.edu/ESD10/block6/Mexico_City_Organizations.pdf (consulted on 16/11/04).

[68] National Council of Sustainable Development, *Sustainable Development Report* http://www.ncsdnetwork.org/global/reports/ncsd1999/mexico/english/ (consulted on 16/11/04).

[69] National Institute of Ecology, INE, http://www.ine.mx, (consulted on 28/09/04). The information concerning this institution was gathered through this webpage.

that coordinates experimental approaches in the field of research, dealing with the pollution-control of technologies, as well as monitoring and categorizing pollutants, substances and waste in all environmental matters.

Moreover, the INE aims at strengthening the national and international link between academic institutions. This enforces the professional capacity of human resources, as well as improves the knowledge of the actual researchers, who are under a multidisciplinary framework that comprises natural and social science. Moreover, it seeks to enforce research and scientific cooperation within the environmental sector aiming at obtaining public recognition as a scientific environmental authority; its goal is to become a link between the academic research area and the governmental decision-making body, influencing the proper creation and implementation of public policies.

The second agency is the PROFEPA (Office of Attorney General for Environmental Protection) that deals with all national enforcement responsibilities, including inspecting facilities under SEMARNAT jurisdiction to ensure that the people and industry are complying with their permits and filing civil complaints against violations.[70] PROFEPA also supervises and monitors improvements on the application of environmental and atmospheric legislation.

The evolution experienced by the national institutions in their structures is linked mainly to the increasing concern over aspects related to the establishment of a normative framework, better use of natural resources, environmental industrial regulation, air quality, decentralization, communication, social participation, information and evaluation, as well as the challenge of national growth with quality of life. One of the main concerns of the institutional framework is to fulfill constitutional requirements. The fourth article of the constitution establishes that all Mexicans have the right to a proper environment for their own development and wealth, as well as to the protection of their health. These two rights are "social guarantees" that the executive power must preserve, through a proper coordination between the policies, the administration and the legal framework dealing with policy-making. This must take place in the three different governmental levels that exist in Mexico (municipal, state and federal) to facilitate the realisation of these guarantees under the creation of legal instruments applied through the national institutions. It is important to remark that the policies created to deal with those problems should not become focused upon mitigation as opposed to prevention, because if they do so, such policies will fail to achieve their true purpose. However, as it was shown in the previous section it seems that Mexican authorities are failing in this process.

Other institutions have been created with the purpose of dealing with air pollution. The Metropolitan Environmental Commission (CAM), created in 1996, is an example of one of these institutions. Its responsibility is to observe the implementation of governmental plans like PROAIRE, coordinated by SEMARNAT and the state governments.[71] CAM is an important institution because it includes in its decisions several national governmental agencies, including SEMARNAT, the Ministries of Commerce and Industry, Health and Energy and Mining. The main shareholders of different companies like PEMEX (the state-owned oil company) are also included. The president of this institution rotates every two years between the EM and DF governors and the technical secretary rotates between the states' environmental ministers. However, this institution has been confronting funding problems in the development of its programs, as well as harsh criticism from different authors that claim that there is the need to create a new CAM with the support of Massachusetts Institute for Technology (MIT) funds. According to Lezama "while knowledge is one of the problems, the political situation is the binding constraint. The current CAM does not have the authority to do its job properly. It is not allowed to take actions based on stakeholders' needs. It needs constitutional authority to face powerful political and economical groups".[72] In other words, the CAM has not been a modern and efficient institution dealing with the environmental problems that are taking place in the country.

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[70] Op.Cit Mexico City Organization Fact Sheet, p. 2.
[71] Metropolitan Environmental Commission, http://sma.df.gob.mx/cam/cam.htm (consulted on 16/11/04).
[72] Op.Cit. Massachusetts Institute of Technology and Colegio de México, p. 14.

In this chapter different points were exposed. On the one hand, the current situation of different socio-economic factors that have influenced, through their pressure, the policy-making process and outcome of the governmental efforts to tackle the problem of air-pollutants, as well as the role of environmental policies to decrease or solve the negative effects of air pollution in Mexico were analysed. On the other hand, the role of society and institutions concerning their perception of the problem of air pollution was analysed. It is like this that different responses from Mexican authorities have been created to solve the problem of air pollution in the national context. This will be the topic that the next chapter will tackle.

Chapter 4. Overview and assessment of the institutional response to the problem of air pollution.

4.1 Mexico, the current situation and the governmental actions against air pollution

Air quality in Mexico is a topic that is not limited only to big megacities; there exists an awareness to observe the development of medium-size cities as well. The fast urban development of cities, the industrial concentration, the increase of vehicles, the high consumption of fossil fuels and the inappropriate urban mobility are factors that have contributed directly to the increase of attention in the development of medium and large cities, with the purpose to stop, prevent or reverse air pollution.

Mexican authorities together with different institutions such as MIT and others, aim to develop different tools in order to achieve better control of air pollution, decreasing or ameliorating its effects in the society and the environment. The measurement through monitoring systems of the levels of contamination that are present every day in different megacities in Mexico has become one of the principal activities to determine whether the air quality is satisfactory or not, related to national standards that will be explained further in this chapter. The analysis of these measures across time indicates whether there is a rise or a decrease in each one of the pollutants. It is known that these measurements are the best available indexes to evaluate if a city is close to be sustainable in air quality terms and to provide good quality of life to its citizens.

The situation in Mexico concerning air pollution is analysed in the 2002 *National Report of the Environmental Situation in Mexico,* formulated under the responsibility of SEMARNAT. In short, the most relevant aspect that the designed programmes must deal with is the transport system that accounts for 70% of the emissions. According to this report, emissions of HC and NO_2 are very important because they represent 30% of the total emissions, and have a direct role in the formation of O_3 that is the principal pollutant in Mexico City. Special attention is given to PM_{10} particles because this pollutant overpasses the values of the air quality norms frequently.[73] This situation has been evident in six big areas of the country: Guadalajara, Mexico City, Puebla, Monterrey, Ciudad Juarez and Toluca. Results from monitoring shows that in Guadalajara and Mexico City, while the air quality improved due to less violations of the air quality standards, the concentrations of O_3 and PM_{10}, increased. This situation was also presented in the other four areas under examination. According to the *Second Report of Air Quality in Six Mega-Cities*, the increase in vehicles and the quantity of fossil fuels used by the industry sector has raised as a result the level of contaminants.[74]

It is necessary to mention that the Government participates in three levels to improve the air quality. The federal government works on the elaboration of norms and programs to prevent and control air pollution in federal areas and also supports the decisions of the other levels. Local governments work on the prevention and control of the pollution created by all the sources that are part of their jurisdiction apart from the ones that are considered federal areas. Municipal governments apply the policies on the prevention and control of air pollution generated by industrial corporations and public services, as well as mobile sources that are not part of federal areas. They as well are obliged to support air quality monitoring.

The present chapter presents an overview and assessment of the most important responses that the national government through its institutions has designed in order to abate the problem of air pollution, these translated into programs used at the national level having the character of soft law rather than hard law. This overview seeks to analyse their advantages and disadvantages at the local / national level.

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[73] For these reasons with the purpose to have a better observation of the behaviour of the mentioned pollutants and a clearer analysis of the present chapter a statistical review concerning the behaviour of O_3 and PM_{10} pollutants over the years took place. The statistics were taken for the case of Mexico City since this has been the city that the present study focuses on. The purpose of looking at these statistics was to observe the historical behaviour of the main pollutants that are under the norms regulation. These statistics were taken from http://www.sinaica.ine.gob.mx (consulted on 16/11/04).

[74] Susana Ruiz, "Empeora la calidad del aire", *Mural,* (1 September 2004).

4.2 Historical background of air pollution control

Since the Secretariat of Environment, Natural Resources and Fisheries (SEMARNAP) was created in 1994, it was established that the problem of air pollution should be one of the principal topics in the environmental agenda of the country. The General Directorate of Environmental and Information Management (DGGIA) was created under the INE with the purpose of improving management of the activities concerning air quality and environmental information. Different actions took place creating strategic plans between the state governments and the municipalities under a legislative framework such as the LGEEPA. The main developed activities were: atmospheric monitoring, emission inventories, the adaptation and final design of the national Mexican norms (NOMS) and the elaboration of programs to improve air quality (PROAIRE). According to LGEEPA, the DGGIA has to coordinate its actions with the different levels of government due to the fact that the design of the PROAIRES must be implemented according to the needs of the cities. This is the case because each city is characterised by different levels of contamination with different pollutants contributing to the problem. In some of the programs the measures are mainly aimed at the control of pollutant emissions where the quality of the air does not reach critical levels.

Since air pollution is a trans-boundary environmental problem, the National Government and the state governments have joined actions to reduce emissions. An example of this effort is the creation of two plans: PICCA (1990-1995) and PROAIRE (1995-2000)[75]. These programs together with other measures such as rotating one week day ban on private car use, have improved the quality of air in different cities. However, when the levels of pollution are very high, this ban is extended to every second day and some manufacturing activities are cancelled. Apart from this, car owners must have their vehicles certified every six months. Even if these efforts to curb emissions have been relatively successful in reaching the diminution of CO, Pb and NO_2, other pollutants such as PM_{10} and O_3 are still out of control and far away from the quality standards.[76] Moreover, the introduction of these measures has not proven to be successful due to the lack of planning as well as the economic interests of certain groups. This has been the case with the program "hoy no circula" (Day Without a Car" defined as rotating one week ban on private car use or a day without a car.

Since 1989, the Secretariat of Environment and the Secretariat of Communications and Transport in an effort to reduce emission from automobiles established the program "Day Without a Car", with the hope of reducing air pollution, discouraging automobile use, and encouraging the use of alternative transportation. It consists of the rule according to which all cars entering the city could not be driven a specific day of a week —determined by the last number on the license plates—. The Government of the Federal District where this program is taking place, accepts that this program has not achieved the expected success, even though the program has had significant compliance by the population.[77], However, it has been shown that the "Day Without a Car" program has in fact promoted automobile use, rather that discourage it. Since the program does not allow drivers to choose which day of the week not to drive, drivers many times postpone their projected travels to another day of the week, rather than using public transport. Another problem caused by this program has been the massive increase in the purchase of cars. Citizens from medium to high class have opted to buy a second car rather than use alternative means of transport. In relation to that, Lezama mentions that there exists a constant entrance of global car manufactures in the country. This situation has been encouraged by the signature in 1995 of an agreement by the Alliance for the Economical Recovery. This agreement eliminated the tax in new cars and the possibility of financing up to 71% of the investment in the purchase of these vehicles in the case of taxis.[78] In a few words, this program has not created any incentives to decrease automobile usage by the population, and therefore has not accomplished the goal of improving the air quality in the city of Mexico.

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[75] Op. Cit. Mexico City Organization Fact Sheet.
[76] Op. Cit., Hibler, p. 2.
[77] Gobierno del Distrito Federal *Fideicomiso para el mejoramiento de las vías de comunicación del Distrito Federal* (online), México, DF, http://www.segundonivel.df.gob.mx/problemas/2lasmedidas.htm (consulted on 2/11/04).
[78] Lezama, *Aire Dividido,* p. 4

Seven programs were created in the period 1995-2000 for the most problematic areas that were categorized according to their population density, number of industrial concentrations and vehicular density. The information provided by different stations of air quality monitoring concerning the days that the air quality norms were violated was an important source as well. After the period mentioned above finished, the governmental authorities decided to undertake a more ambitious air quality improvement program named PROAIRE 2002-2010. Also, the elaboration of different standards for the productive activities of the country and vehicles took place to prevent and control the emissions of pollutants to the atmosphere.

4.3 Actual air quality situation, monitoring and air quality norm plans

The main pollutants that are monitored in Mexico are the following: SO_2, CO, NO_2, O_3, PM_{10}, PST and Pb. For each one of these pollutants there exists a standard or norm that establishes the maximum concentrations that should not be exceeded in a determinate period of time, to guarantee that the health of the population is protected. [79]

In Mexico the main air quality index that is used is the Indice Metropolitano de Calidad del Aire (IMECA) (Figure 8). The purpose of this index is to give information about air quality in Mexico City as well as to observe the behaviour of the different pollutants, comparing air quality in different zones. Also, it provides a representative value of the atmospheric pollution levels and their health effects for a given area. IMECA is based on two fundamental algorithms; the first one is used to obtain the index from different air quality indicators, while the second one is used for a global index combination of the results. The first algorithm involves segment functions composed of two main breaking points which have been obtained based on Mexican criteria for air quality, and levels for which significant health damages have been detected. A value of 100 was assigned to the first one, and a value of 500 to the second one. Between these two points, three more have been defined to classify the interval into different descriptive terms of air quality. [80] In other words, the concentration that the Air Quality Norm indicates is of 100 IMECA points. Therefore, people know to identify that when the O_3, the particles or another contaminant overpasses 100 points of this index, then the norm has been violated and the air quality is not satisfactory. In between 150 and 200 points IMECA the air quality is bad and above 200 points is very bad. For a better understanding the next graphic is presented:

IMECA	AIR QUALITY	EFFECTS			
0-100	Satisfactory	Favourable conditions to make any outdoor activities			
101-200	Non Satisfactory	Minor annoyances in sensitive people and organisms			
201-300	Bad	Annoyance increase in persons with respiratory problems			
301-500	Very bad	Appearance of several symptoms and potential problems in healthy people			
IMECA	Satisfactory 0 - 100	Not Satisfactory 100 - 150	Not Satisfactory 150 - 200	Bad 200 - 300	

Figure 8. Source: Sistema de Monitoreo Ambiental (Environmental Monitoring System)

One of the main preconditions to evaluate the air quality in a determinate area is to have a proper atmospheric monitoring system. However, this is a very expensive activity that overpasses frequently the budget of municipal authorities. The total cost to construct each monitoring station is approximately $170 million dollars; moreover, full-time qualified personnel and one car per four stations are needed. Their maintenance is also important; therefore an annual budget of at least $100

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[79] Gobierno del Distrito Federal, *Informe del Estado de la Calidad del Aire y Tendencia*s para la Zona Metropolitana del Valle de México, (México DF, Gobierno del Distrito Federal, 2003), p. 14.
[80] SIMA, Sistema de Monitoreo Ambiental, http://www.sima.mx/df/conteng.html (01/11/04).

million dollars is necessary[81]. Fernandez mentions that in developed countries the basis of the elaboration of the air quality norms is formed according to epidemiological and toxicological studies that are dependant upon good monitoring systems. In contrast, in Mexico there are neither the economical resources nor the infrastructure to develop the necessary studies to elaborate adequate air quality norms. This is the reason why Mexico has adopted similar limits to the ones of the United States of America, or the ones suggested by the World Health Organization (WHO)[82]. However, it is possible to say that the adoption of these standards to the Mexican situation can represent different problems due to the difference between populations. But at least this adoption allows policy makers to establish pollution limits that develop the evaluation of the air quality in different megacities as well as the development of programs of air control.

At the beginning of 1995, in Mexico City, Guadalajara, Monterrey and Toluca there was a constant air quality monitoring. In the last five years the monitoring capacity has greatly improved in the whole country, with international, national, local and municipal financial support creating monitoring stations in Ciudad Juarez, Tijuana, Mexicali, San Luis Potosi, Puebla, Manzanillo, Aguascalienetes, Salamanca, Villahermosa and Zacatecas (Figure 9).

**Figure 9. Cities in Mexico that have automatic nets of
atmospheric monitoring united to the SINAICA
Source: Sistema Nacional de la Calidad del Aire (SINAICA)**

4.4 Programs for improvement of air quality in the main cities and metropolitan areas of the country (PROAIRE):

The most advanced instrument that has been developed for the control of air pollution has been the program PROAIRE.[83] This program includes acute measures for the abatement and control of the emission of pollutants. Its basis of action is taken from the relationship between the pollutant emissions and the sources that produce them as well as the impact that they present for the air quality and the health of the population.

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[81] Op. Cit., Fernández, p. 6.

[82] Ibid., p. 3.

[83] SEMARNAT, Gobierno *Programa para Mejorar la Calidad de la Calidad del Aire de la Zona Metropolitana del Valle de México 2002-2010,* Comisión Ambiental Metropolitana, (México DF, 2002), p. 2.

This program has both a short and a long term perspective to control the detriment of the air quality, trying to maintain the main pollutants among the standards established by the air quality norms. Furthermore, this program pays particular attention to the sources that produce air pollution and designs air pollution reduction measures under a rational cost. The general objectives are: improvement of public transport, improvement of fossil fuels, urban planning, modernization of vehicles of public service, programs of environmental contingencies, vehicular emissions verification, more strict norms, industrial inspection, education, reforestation and re-arrangement of streets in critical zones.

Nowadays, the instrument that is taking place is PROAIRE 2002-2010 for Mexico City. However, this program is based on the previous PROAIRE and is checked twice a year with the purpose of continuity with the objectives and strategies established by the previous PROAIRE. The possibility of modifying or reconstructing the ones that are not effective and include new ones is present in this assessment. This is the first time that a 10-year programme is planned. This program puts together the different intergovernmental institutions, the private sector, the educational sector and civil society, in order to achieve the reduction and better control of pollutant emissions that violate the air quality norms for the protection of human health. This seeks to integrate different sectors of the society to make it more legitimate. In the case of the rest of the cities where PROAIRE is taking place, the programs that were designed in the previous presidential period are still taking place with almost no changes. It is planned to create future programmes similar to PROAIRE 2002-2010 for the cities of Guadalajara and Monterrey. This situation is really urgent in cases such as Guadalajara which is currently exceeding Mexico City in critical levels of CO, NO_2 and particles. From the five indicators that measure the air pollution, Guadalajara exceeds Mexico City in three of them and has the tendency to be equal in the other two. This situation has been present since 2001. According to the INE, in 2001 the air quality norms concerning O_3 were violated 36 days of the year, in 2002 the days the norm was violated were 75 and in 2003 69. Concerning PM_{10} in 2001 the norm was violated 41 days, the next year 39 and in 2003 it was reported 38 days. However, the local government assures that the air quality is much better than the one registered in 1997, so in reality the situation improved once PROAIRE entered in action. Currently, the Government accepts that there is still a lot to do concerning the air quality of Guadalajara; for those reasons they are considering to reinforce some of the objectives of the program.[84]

What follows is a brief description of the objectives and strategies of PROAIRE in different cities. [85] For Mexico City the application of PROAIRE 1995-2000 was designed with the expectation to eliminate 50% of the emissions of hydrocarbons, 40% of NO_2, and 45% of particles. This was supposed to decrease the values of IMECA from 170 points to 140 and 150 in the year 2000. The main strategies proposed were the incorporation of new technologies in the industry and services and the improvement and substitution of fossil fuels in the industry, services and vehicles. Furthermore, they included a better development of urban transport systems and the integration of metropolitan policies, the application of economical incentives, inspection and surveillance of industries and vehicles, and an increase and promotion of environmental information and education, as well as social participation.

In the case of Guadalajara PROAIRE 1997-2000, the program established 31 measures with which it was estimated that the percentage of days with air quality problems should be reduced in 7% as well as the average of 70 IMECA points of the air contamination with an average of 50 IMECA points by the year 2000. Also it was estimated that there would be a reduction of 30% in particle emissions, 10% in hydrocarbons and more than 30% in NO_2, these last two pollutants being the main precursors of ozone. In the case of Monterrey PROAIRE 1997-2000, the program developed 6 subprograms based on 45 projects described on it. It had been estimated that the percentage of days with low air quality would have been reduced 10% for the year 2000. In Toluca 1998-2000 following the analysis of the emission reports and the behaviour of the data concerning air quality, 40 actions

[84] Daniel Rodríguez, "Supera en contaminación Guadalajara al DF", *Mural* (8 September 2004).
[85] Op.Cit. SEMARNAT et al. *Almanaque de tendencias y de la calidad del aire en seis ciudades mexicanas*. See also SEMARNAT, Gobierno *Programa para Mejorar la Calidad de la Calidad del Aire de la Zona Metropolitana del Valle de México 2002-2010,* (Mexico DF: Comisión Ambiental Metropolitana, 2002).

have been incorporated that offer recommendations given by the municipal, local and federal government, universities, NGO's, industrial and commercial chambers. With the application and the fulfilment of these actions it had been expected to reduce the levels of contamination with a final result of the reduction of 27% of hydrocarbons, 24% of NO_2, 26% CO_2 and 44% of particles by the year 2003. This was part of an effort to eliminate the days in which the air quality norms were violated; however, the programs had only a partial success.[86]

To conclude, after the analysis of different yearly statistics of the pollutants that are under the air quality norms for different cities of Mexico such as Mexico City, Guadalajara, Monterrey and Toluca it is possible to say that in the main metropolitan zones of the country, where air contamination is one of the biggest environmental problems, PROAIRE programs were created with important achievements since they started to take place. However, these results are not enough to decrease critical levels of some pollutants. On the other hand, the reached achievements were positive in the sense that the attention was focused in the use of better fuels in the industry sector as well as the use of cleaner combustibles and more efficient transport. An example of this is the fact that the Mexican gasoline currently fulfils international standards. Nevertheless, there is evidence that these actions are not enough and that there is still a lot of work to do concerning the decrease of other pollutants, like O_3 and PM_{10}. One of the critiques that could be pointed out concerning the PROAIREs is that they only seek to reduce those pollutants that violate or overpass the air quality norm. Apparently, the program should also take into consideration the values that do not reach these points to decrease the pollutants to an optimum point. Another problem is the holistic vision of the pollutants that the program has. This represents a problem because two different pollutants such as SO_2 and PM_{10} produced by different sources should not be treated in the same way due to the different effects and implications that they can produce. Another clear example can be found at the Mexican border with the USA where the main pollutant is O_3 and not PM_{10}. However there is a very different situation in Guadalajara or Toluca where the main concern is the opposite. Also, concerning the analysis of the behaviour of the pollutants it is possible to say that PROAIRE has been successful but in reality the levels that are registered point out that the levels of protection to the human health are violated at least 77% of the days per year. There are doctors and academics that mention that there are increases in the mortality rates.[87] PROAIRE has a very ambitious goal and this is to reduce the critical levels of O_3 and PM_{10}; however, it does not state until which levels and when. Another point is that there should be an evaluation of the program taking in account the population's opinion, and their perception of the efficiency of the measures that are already taking place. Up to now there has not been any public evaluation from the government to know how people perceive and assess PROAIRE.

4.5 Air quality norm: Norma Oficial Mexicana (NOM)

The air quality norms establish the maximum concentrations of pollutants on the air. These concentrations should not be exceeded more than once a year to guarantee the protection of the human health. So, the main purpose of the air quality norms is to protect the human health of the population, emphasizing the protection of more vulnerable groups like kids, elderly and persons with acute respiratory problems.

These norms were designed by the Secretariat of Health and were published in the Diario Oficial de la Federación (the official and unique information source from the government) on the 23rd of December of 1994, with a modification to the norm for O_3 published on the 30th of October of 2002 in coordination with the SEMARNAT, academics, industrial sector and environmental groups. Figure 10 presents the values that the air quality norms give to the principal pollutants. In the first column are the pollutants. The next columns are divided in three lines; the first establishes the maximum limit values, the second is divided between the acute and chronic exposition, the third is divided first by the maximum time and concentration, secondly by the maximum acceptable frequency and third represents the values for the protection of the health of the population that is considered as vulnerable.

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[86] Op.Cit. SEMARNAT et al, *Almanaque de tendencias y de la calidad del aire en seis ciudades mexicanas.*

[87] O'Neill, Loomis and Borja-Aburto, "Ozone, area social conditions, and mortality in Mexico City," *Environmental Research Journal*, (2003), p. 234.

With * is represented the annual arithmetical average and ** the three-month arithmetical average.

Values of norms for pollutants

Pollutant	Limit values		Chronic exposure
	Accute exposure		For the protection of the susceptible population's health
	Concentration and average time	Maximum acceptable frequency	
Ozone (O$_3$)	0.11 ppm (1 hour)	1 time each 3 years	-
Sulphur dioxide (SO$_2$)	0.13 ppm (24 hours)	1 time per year	0.03 ppm (*)
Nitrogen dioxide(NO$_2$)	0.21 ppm (1 hour)	1 time per year	-
Carbon monoxide(CO)	11 ppm (8 hours)	1 time per year	-
Suspended particles (PST)	260µg/m^3 (24 hours)	1 time per year	75 µg/m^3 (*)
PM$_{10}$	150µg/m^3 (24 hours)	1 time per year	50 µg/m^3 (*)
Lead	-	-	1.5 µg/m^3 (**)

Figure 10. Values of air quality norms for different pollutants   (*) arithmetic average per year
Source: National Institute of Ecology http://www.ine.gob..mx (**) arithmetic average per three months

The air quality norms (Figure 9) are divided by sectors. Industry has 13 and these are divided according to the production of sulphuric acid (S), cement production (particles), production of acid docedilbecensulphuric (S), separation of water and oil in refineries (VOC's), cellulose production (S) and the painting of new cars (VOC's), vehicles 10, monitoring systems 5, fossil fuels 2. For example, concerning new vehicles there is the NOM-042-ECOL-1999 that establishes that the new vehicles are free from vehicular emissions verification in the first two years and do not participate in the programme "day with out car". Another example concerning the vehicles in circulation is the NOM-041-ECOL-1999 that establishes different emission limits depending on the year of the car, with more strict limits to Mexico City, especially for vehicles of intensive use. In the case of pollutants containing SO there are 6 norms, with NO$_2$ there are 6 norms, particles 8 norms, VOCs 10 norms and CO 6 norms. In general the objective of the federal legislation for air quality is the protection of human health and the ecosystems. The establishment of limits for different areas that are considered critical and for the rest of the country specifies the time for the fulfilment of the processes that are under the norms and promotes the improvement of the quality of fossil fuels.

In general and following the analysis of the behaviour of the pollutants that are measured in Mexico, there is a tendency to violate the norms in different areas. In that sense, the regulation that the norms establish is often weak and ambiguous. Thus, it is easy to violate the norm due to the fact that every person and sector gives the interpretation that it wants. Another problem that the norms confront is the lack of metropolitan coordination to establish coordinated actions, as well as corruption that makes norms even harder to follow. This situation has been evident in the case of vehicular emission control programs that are coordinated by the government and where it is well known that by giving money to the personnel working there once the car does not have the necessary standards, the owner of the car receives the qualification to continue polluting.

4. 6 The National System of Air Quality Information

The National System of Air Quality Information (SINAICA: Sistema Nacional de Información de la Calidad del Aire) is a programme that gathers and communicates trough the INE web page the data produced by the main nets of atmospheric monitoring in Mexico. Its purpose is to show the actual and past situation of air quality in different cities of the country. SINAICA has three subsystems: 1) information in almost real time that is showed trough the Internet in an automatic form from the Atmospheric Monitoring Nets, which allows access to the information that this system produces concerning pollutants and meteorological variables, 2) databases produced from the Atmospheric

Monitoring Nets, providing indicators of the ain pollutants produced in different cities of the country, and 3) historical databases, which inform the population about the behaviour of different pollutants.

Nowadays SINAICA has monitoring nets around different cities in Mexico like Mexico City, Guadalajara, Toluca and Puebla. It is planned that in the year 2004 new stations should be installed in cities like Salamanca, León, Celaya, Irapuato, Ciudad Juárez, Tijuana-Rosarito-Tecate and Mexicali. In the long term SIANICA will be the main source of information for the whole country.

4.7 The General Law of Ecological Balance and Protection to the Atmosphere (LGEEPA)

The General Law of Ecological Balance and Protection to the Atmosphere (LGEEPA),[88] considered as a hard law, was created in 1988 as one of the main legal instruments for the prevention of air pollution in Mexico. In 1996 a total reform was made to this law with the purpose of incorporating the concepts of sustainability and biodiversity emerged from the 1992 Rio Earth Summit. This law assigns several responsibilities to the national government. First it issues "standards" for air quality, which include a range of functions such as ambient air quality criteria, maximum permissible levels for air pollutants released by industrial sources and emissions limits for vehicles. Secondly, it provides permits for industrial facilities under federal jurisdiction. This includes most heavy industry (chemicals, energy, metals, cement, paper, cars, and transport) as well as all other industry in the Federal District. These facilities must install air pollution control equipment, monitor to ensure limits are being met, and submit emissions inventories. Thirdly, the federal government has primary responsibility for enforcement, including a range of civil and criminal sanctions. The government may, in agreement with state or municipal officials, delegate all or some of its enforcement functions.[89]

The main action that concerns the LGEEPA for the protection of the abatement of air pollution is to avoid the disordered growth of the activities that can affect the atmosphere. For example, for the establishment or modification of a new industry it is necessary to have permission that is only granted after a study of the area takes place to evaluate the impact that this industry can cause to the atmosphere. Concerning the control of polluting activities, this law releases rates that must be respected and gives the amounts of polluting agents that can be emitted to the water and the air, by industries and transport. It also establishes that the emissions of polluting agents to the atmosphere must be reduced and controlled to assure air quality for the well-being of the population and the maintenance of the ecological balance. One of the included aspects in the last modification of the law is that it establishes that citizens have the right to access environmental information. This is an indispensable condition to give transparency and legitimacy to the environmental management of the authorities and the policy-making process.

Two other legal instruments that have developed against air pollution in Mexico are: a) Legal Evaluation of Environmental Impact and b) Legal Investment on Research Programs and Experimental Development. The former instrument works since 1986 with different reforms in 1998 and seeks to guarantee that environmental impacts are included in the process of decision-making and planning. The latter instrument manages the total national expenses in scientific research and experimental development about air pollution. Scientific research is a fundamental activity in order to promote the knowledge and development of evaluation tools about air pollution problems. Problems such as the concentration of pollutants in the atmosphere, the growing air pollution, the continuous loss of ecosystems are some of the main concerns that demand new developments in the scope of research and experimental development. As part of the broader aim of sustainable development, it is very important to know the tendencies on this kind of expenses.[90]

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[88] General Law of Ecological Balance and Protection to the Atmosphere.
http://www.semarnat.gob.mx/pfnm/LGEEPA.html (consulted on 16/11/04).
[89] Op. Cit, Mexico City Organization Fact Sheet, p. 1
[90] Mexican Laws in English, environment http://www.mexicanlaws.com/contamination_of_the_atmosphere.htm (consulted on 28/10/04).

All these tools represent important partial achievements in an effort to decrease, control or prevent air pollution. But there are different factors that function as obstacles for these tools to work properly. According to the 2004 4th Report of Government, a speech given by President Vicente Fox Quezada, in order to improve the air quality in different parts of the country it is necessary to confront different challenges. These are: integrating sectoral policies from transport, energy and human development with the protection of the environment; strengthening the monitoring system of air quality in the principal cities; investigating and evaluating the levels of exposition to pollutants and the effects on human health, as well as developing a proper analysis in financial terms; reaching the social recognition of the financial costs of air pollution and the necessary actions to abate this problem and to guarantee the effective fulfilment of the norms in the industrial and transport sectors.[91]

4.8 Some measures to abate air pollution from personal vehicles

Nowadays, modern societies through the dominant lifestyle have made an intensive use of motor vehicles, for the transport of persons or goods. The improvements that different transportation systems have faced since their creation have moved further away from aesthetics or comfort to the speed and security in which passengers or goods can travel to their destinations. In this sense, mobility is a key factor for mega cities like Mexico City where societal functions such as transportation for work, school, and social life take place every day. What mode of transportation a person chooses to use depends on many variables that can include income, availability of mode of transportation, time of day, time available, and comfort standards.

In Mexico, the transport system is the main contributor to air pollution in the country and vehicles are its main source. The National Government created different measures that have been taking place. The first programme is the reduction of the use of private vehicles through the implementation of the "hoy no circula" program that was analysed in the previous chapter. The second program that is taking place is named "stopping days"; these are randomly distributed, encouraging car owners to use public transport and/or adopt car-pooling. The third program concerns the control of vehicle conditions and the interrelated control of vehicular emissions. This is a verification program that evaluates the condition of the engines in cars to report how much emissions are emitted to the air and accordingly bans or allows the cars to transit in the streets of the cities. The fourth program is the substitution of fuels and concerns mainly the substitution of lead and sulphur in fuels. This is because the quality of the gasoline has improved. Finally, the fifth program concerns the compulsory implementation of catalytic converters.[92] It is considered that these strategies by their own will not represent a total control of air pollution; they are only instruments to reduce the impact of air pollution.

This chapter analysed the different programs and instruments that are taking place in Mexico as a response to the air pollution problem, and presented their advantages and disadvantages. It is possible to point out that even if the levels of air pollution have decreased in the last years, there are still pollutants that represent a problem to the health of the population. In this sense it is necessary to reinforce the legal instruments as well as the programs to guarantee that the level of these pollutants will be at least under control until their future decrease. Moreover, the soft law character of the programs, as well as hard law, present a weak binding character and are violated constantly. It is in these terms that the improvement of the main driving instruments should take place. In addition, more research should be done in order to clearly identify the sources of these pollutants and regulate them accordingly.

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[91] Web page of the Presidency of the Republic, http://cuarto.informe.presidencia.gob.mx/index.php (consulted on 29/10/04).
[92] Op. Cit Yip and Madl, p. 9.

5. Conclusions and recommendations

Concerns over the effects of air pollution to human health have been nowadays the main driving force behind relevant policy initiatives and actions in Mexico. However, the quantity of pollutants that are discharged in the atmosphere is still far from optimum. In Mexican mega-cities with monitoring systems, the estimates indicate that the major contributions of pollutants come from the transport sector, and especially from the use of private cars. Under these conditions, there is a need to create programs that aim at reducing emissions from this sector. This situation, along with the harm caused to the ecosystems as well as the violation of the environmental standards concerning O_3 during more than 250 days a year, is still placing Mexico City as one of the most polluted cities of the world.

There is no doubt that there has been some success in the environmental policies of the Mexican Government to abate the problem of air pollution. One of the results has been the reduction of the number of days that the air quality standards negatively exceed the 150 IMECA points limit. This is a proof of the slow but consistent effort that started in the '90s with the program PICCA. The elimination of lead and the improvement of the gasoline quality as well as the introduction of catalytic converters and the adoption of new technologies are some of the main measures that have assisted the partial success of the programs. However, the failure of measures such as "hoy no circula", or the not so strict character of programs like "vehicular verification" should be taken into account in order to improve such measures. The serious problem of pollutants like O_3 and PM_{10} must also be taken in consideration. Therefore the achieved results cannot be considered as sufficient for the solution of the problem of air pollution in Mexico.

Thus, there still important actions to be taken. This has a lot to do with the improvement of the quality of the fossil fuels, especially the reduction or elimination of SO, the modernisation of vehicles for public services as well as private cars, and the fulfilment of the norms, rules, regulations and laws by the society, the industries and different sectors. It is well known that if the legislation and norms were respected, there should be a significant reduction of air pollution, avoiding with this the acts of corruption. A decisive obstacle to improvement is the lack of linkages between different governmental policies, such as transport policies and urban planning. Transport policies have not been very coherent, and their practical application does not fully correspond to the initial policy planning. For example, despite the improvement of public transport that policy-makers suggested in the last presidential period, disorder and lack of authority rather than efficiency and functionality prevail in that area. All these problems tend to merge with a bigger one, the lack of coordination and authority in different governmental levels, and explain the only partial success of the Mexican "air policy".

Decentralisation of financial resources and empowerment of the municipal institutions, so that they become able to initiate and operate programs with appropriate budget are two very important aspects for future reform. Moreover, negative tendencies over the functionality of the cities should be reversed, especially with regard to mobility. Information should be in general available to the public, higher levels of transparency should be achieved and more educational programs should take place. Overall, the public should receive more incentives in order to participate to the design of policies and programs, in order to fulfil the real needs of the society. In other words, an effective governmental coordination and an active social participation should be achieved.

The present paper attempted to present an analysis and evaluation of the current policies that Mexico has adopted in order to combat air pollution. To this end, a specific conceptual framework was followed, providing an integrated view of the environmental problem under consideration, and its interrelated aspects. The state of the environment concerning air pollution was exposed, together with the impact of this phenomenon to the society and the environment. Finally, the responses that the Mexican government has designed in order to solve the problem were presented and assessed.

It is possible to say that since the aim of the research concerning the evaluation and analysis of the current policies that Mexico adopted to combat air pollution, was presented answering the research

questions, the hypothesis and the objective. The application of the conceptual framework was followed to give coherence to the study, providing an integrated view of the environmental problem studied and the interconnected aspects. The state of the environment concerning air pollution was exposed, the impact in the society and the environment were analysed and finally the responses that the Mexican government designs to solve the problem were mentioned.

After this exposition it is possible to remark that this study showed that air pollution is a social problem. According to the information given by the Newsletter CIMAC in its article published on Tuesday 6 of November of the 2001[93], it is important to notice how the national agenda has big gaps in its application to Mexican policy. This appears in the way actors define the emergence, the severity, the magnitude, the government capacity to solve the problem, the role of science in the policy-making process, and in the possibilities, obstacles and solutions that these actors suggest. But it is also possible to notice the relative general agreement on the importance of this problem as well the way in which actors compare it with other environmental issues. Therefore, it is possible to say that the reason that all these programs have shown partial effects in solving this problem is because air pollution programs did not regard the problem as the result of social factors. This is so, despite the fact that some of the most important social actors are involved in the issue, had a social perspective of the problem and also that governmental programs regarded government as the main forum for programmatic intervention in this problem. Heterogeneous developments at the country's regions, country impoverishment and unsustainable production patterns have contributed to the increase of environmental problems related to development. Changes in the use of soil and agriculture border expansion caused by the persistence of intensive agricultural practices repeat patterns of marginalization and poverty. Governments have not taken responsibility for formally involving the citizens in the design of public environmental policies. There are no diagnostics based on deep analysis that evaluate use, access, handling and benefit on natural resources.

Even though environmental education is better positioned in government policy, the problem is that there is a lack in spreading the right information in different education levels and there is no proper training for teachers about environmental subjects. Environmental education has not helped the social transformation that this problem requires. In addition, the scientific environmental research is very slim, not sufficiently encouraged and unlinked to actual problems; hence, it gives a very limited contribution to solve actual problems.

Finally, the Mexican governance together with the international and Americas´ economic environment are factors that should be taken in consideration to contribute to the efficient solution of environmental problems like air pollution. The reason for this is that in Latin America and in Mexico, there is no control over the international economic environment as a result of the market liberalisation of the global economy, becoming highly vulnerable to global economical changes. This is well demonstrated by the case of the automobile industry in Mexico where the actual economic model has allowed the massive entrance of automobile companies. The need of strong governments to capitalize in the market liberalization and of firm societies to tolerate the adjustment to the cost of these changes is necessary. [94]. After this account, it is possible to say that in spite of some achievements, certain challenges still persist, which require a new vision of sustainability and a higher compromise from people and government, acting together in order to deal with them successfully.

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[93] Noticiario CIMAC, http://www.cimacnoticias.com/noticias/01nov/01110606.html (consulted on 02/11/04).
[94] FOCAL, *Cuál futuro para las Américas? Cuatro escenarios*, fundación canadiense para las Américas, 1995, p. 49

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